STATEWIDE ECONOMIC STUDY 2002

ARIZONA'S ENERGY INFRASTRUCTURE

September 2002

Prepared for the Arizona Department of Commerce

by

Rebecca Holmes, Senior Economist, Salt River Project and
Craig A. Marks, Director, Energy Office, Arizona Department of Commerce

in collaboration with

Jerry Conover, Ph.D.
Director, Bureau of Business & Economic Research
Northern Arizona University

ARIZONA'S ENERGY INFRASTRUCTURE

September 2002

Prepared by:

Rebecca Holmes
Senior Senior Economist
Salt River Project

Craig A. Marks
Director, Energy Office
Arizona Department of Commerce

In collaboration with:
Jerry Conover, Ph.D.
Director, Bureau of Business and Economic Research
Northern Arizona University

Peer reviewed by the Technical Advisory Committee for Arizona Statewide Economic Study 2002:

Dan Anderson
Assistant Executive Director for Institutional Analysis
Arizona Board of Regents

Brian Cary
Forecast Consultant
Pinnacle West Energy Corporation

James B. Nelson
Economic Development Manager
Salt River Project

William P. Patton, Ph.D.
Director of Economic Development
Tucson Electric Power

Tom Rex,
Research Manager
Center for Business Research, L. William Seidman Research Institute, College of Business,
Arizona State University

Carol Sanger
Assistant Deputy Director for Planning, Research and Policy
Arizona Department of Commerce

Mary Lynn Tischer, Ph.D.
Director, Transportation Planning Division
Arizona Department of Transportation

Marshall Vest
Director, Economic and Business Research
Eller College of Business and Public Administration
University of Arizona

Technical review by:

Gary A. Smith
Vice President and General Manager
Citizens Communications, Arizona Gas Division

Jerry Smith
Electric Engineer
Utilities Division, Arizona Corporation Commission

William P. Patton, Ph.D.
Director of Economic Development
Tucson Electric Power

Brian Cary
Forecast Consultant
Pinnacle West Energy Corporation

Kathy Senseman
Government Affairs Specialist
Southwest Gas

This report was prepared for the Arizona Department of Commerce in conjunction with the 2002 Arizona Statewide Economic Study (SES) with funding from the Commerce and Economic Development Commission. Elements of the SES may be presented independently elsewhere at the author's discretion. The entire body of work comprising the SES will be available on the Internet for an indefinite length of time at http://www.azcommerce.com/prop/ses.htm. Inquiries about this report or the SES should be directed to the Office of Economic Information and Research, Arizona Department of Commerce, (602) 280-1300.

ARIZONA'S ENERGY INFRASTRUCTURE

September 2002

TABLE OF CONTENTS

ARIZONA'S ENERGY INFRASTRUCTURE

September 2002

Rebecca Holmes, Senior Economist, Salt River Project and
Craig A. Marks, Director, Energy Office, Arizona Department of Commerce
in collaboration with
Jerry Conover, PhD., Director, Bureau of Business Research,
Northern Arizona University

INTRODUCTION

This analysis of energy infrastructure covers the electricity, natural gas and petroleum product industries in Arizona and the Western United States. Major topics discussed include:

- A description of the major providers of electricity and natural gas in Arizona including service territories, average prices, and ownership structure
- Current and planned conventional electricity generation
- Solar and other renewable generation
- Developments and issues in the transmission of power within the West including Regional Transmission Organizations and transmission constraints in Arizona
- Status of electricity and natural gas restructuring activities in Arizona.
- Current and planned natural gas transmission capacity
- A description of petroleum product usage and product prices in Arizona
- Developments and issues in petroleum product delivery in Arizona.

Energy is an essential commodity in the modern world. It powers our cars, lights our houses, and fuels our industrial production. Access to reliable and affordable energy is key to the continued success of any industrialized economy. As the oil embargos of the 1970s and the California energy crisis of 2000-2001 demonstrated, disruptions in the supply of energy can have significant adverse impacts on the quality of life of those affected.

During the 1990's energy use by end-use consumers in Arizona grew at an average rate of 2.7 percent per year, more than twice the 1.2 percent per year demand growth for the nation.[1] Arizona's rapid population and economic growth was the reason for the rapid increase in energy demand. For every percentage point increase in Gross State Product (GSP), Arizona energy demand increases by about half a percentage point.

Although Arizona's consumption of all major energy sources increased during the 1990's, the most rapid increase was in the demand for petroleum products, with consumption increasing at the rate of 3.6% per year. Electricity demand increased at the rate of 2.6% per year, and natural gas demand increased by

[1]Department of Energy, Energy Information Administration, *State Energy Data 1999*

1.5% per year.[2] As Arizona continues to experience robust growth, Arizona's energy providers face the challenge of meeting rising demand and ensuring a reliable and affordable energy supply for the state.

Arizona faces similar challenges as the rest of the nation in ensuring a reliable energy supply. The last two years has seen a boom in the construction of new power plants in Arizona, providing an abundant supply of power for years to come. However, transmission constraints in Arizona and throughout the West pose potential problems for power plant owners in delivering that power to customers.

Similarly, rapid population growth has increased demand on the petroleum pipelines that serve Arizona, raising questions as to the adequacy of these resources to provide for our future needs. Arizona's natural gas pipeline resources are similarly strained. Although growth in natural gas demand was sluggish during the 1990s, future demand for this fuel will increase rapidly as new natural gas-fired power plants begin operation.

Arizona's energy providers are striving to build the resources necessary to meet the State's growing energy needs. New transmission lines are under construction, and new natural gas and petroleum pipelines have been proposed. The successful completion of these projects will help to ensure Arizona a future of reliable and low cost energy.

ELECTRICITY

Arizona's Electric Service Providers

Arizona has a patchwork of electric utilities, with electric service territories in nonadjacent areas throughout the state. According to the Department of Energy's Energy Information Administration, 48 electricity providers officially served Arizona in 2000. However, only 33 of those companies served residential, commercial, or industrial customers (most of the other providers served irrigation customers). Concentration is high in the state, with the top five providers serving 92% of the state's customers. Figure 1 lists the top five utilities ranked by number of customers, their market shares and average revenue per kilowatt-hour ($/kWh) for 2000.

FIGURE 1

TOP 5 ARIZONA ELECTRIC DISTRIBUTION COMPANIES, RANKED BY NUMBER OF CUSTOMERS IN 2000

Provider	Customers	Pct of State	Revenue (000 $)	Pct of State	Sales (000 kWh)	Pct of State	Average $/kWh
Arizona Public Service	836,129	38%	1,803,321	42%	22,411,486	39%	$0.0805
Salt River Project	715,714	33%	1,386,986	32%	21,446,691	37%	$0.0647
Tucson Electric Power	338,705	16%	645,738	15%	7,927,544	14%	$0.0815
Citizens Communications	70,622	3%	93,634	2%	1,052,596	2%	$0.0890
Sulphur Springs Valley Electrical Cooperative	40,220	2%	47,647	1%	492,703	1%	$0.0967
Balance of the state	174,805	8%	317,881	7%	4,769,626	8%	$0.0666

*Source: Energy Information Administration, Form EIA-861, "Annual Electric Utility Report".

The state's largest utility, Arizona Public Service (APS), has service territories in every Council of Government (COG) region in the state. APS serves 11 of the 15 counties in the state, including customers in the Phoenix, Flagstaff, and Yuma metropolitan areas, as well as in many non-metro areas in

[2] ibid. Does not include electric utility demand. If electric utilities are included, the growth rates are: 3.5% petroleum, 5.2% electricity, 1.3% natural gas, and 3.4% total.

the state. APS is a subsidiary of Arizona-based Pinnacle West Capital Corporation. Pinnacle West is an investor-owned company (IOU) with five subsidiaries. Other Pinnacle West subsidiaries include energy generation company Pinnacle West Energy, retail energy service provider APS Energy Services, SunCor Development Company, and El Dorado Investment Company.

Salt River Project (SRP) is Arizona's second largest utility. The majority of SRP's customers are in Maricopa County, with a small number of customers in Eastern Pinal County. SRP is actually two companies: the Salt River Project Agricultural Improvement and Power District and the Salt River Valley Water Users' Association. The first entity is a publicly owned utility with elected directors and officers that operates as a political subdivision of the state of Arizona. This company provides electricity distribution, transmission, and generation services. The second company is a private corporation that delivers water to users in the Phoenix metro area.

Tucson Electric Power serves the Tucson metropolitan area and Fort Huachuca. TEP is a subsidiary of UniSource Energy, a publicly traded company. TEP owns and operates generation, transmission, and distribution facilities. UniSource has two other subsidiaries: Millennium Energy and UniSource Energy Development. Millennium is an unregulated company that invests in energy-related ventures. UniSource Energy Development engages in developing generation resources.

Citizens Arizona Electric is a subsidiary of Citizens Communications Company. Citizens serves customers in Mohave and Santa Cruz counties. Kingman, Lake Havasu City, and Nogales are the largest cities in Citizen's electric service territory. Citizens is a distribution and transmission company only; it owns no significant generation resources. Historically, Citizens has bought power from APS for delivery to its customers.

Citizens Communications Company is a publicly traded company that specializes in telecommunications. Citizens is currently seeking to sell all of its non-telecommunications businesses, including its Arizona electric business. To date, no buyer has been announced.

Sulphur Springs Valley Electrical Cooperative (SSVEC) serves Southeastern Arizona, with the bulk of its customers located in the Central Arizona Associations of Governments (CAAG). Willcox, Benson, and Sierra Vista are the largest communities served by SSVEC. SSVEC purchases all of its energy from the Arizona Electric Power Cooperative (AEPCO).

AEPCO is owned by seven member cooperatives that serve rural areas of Arizona and Southeastern California. AEPCO generates and sells electricity to five electrical cooperatives in Arizona and one in California.[3]

The remaining 28 utilities in Arizona serve mostly rural customers. Most are either publicly owned (15), cooperatives (9), or federally operated (2).[4] Only two of these smaller utilities are investor-owned: Morenci Water and Electric Company in Greenlee county, and the Ajo Improvement Co. in Pima County.

---

[3] AEPCO's member cooperatives are: Sulphur Springs Valley Electrical Cooperative, TRICO Electric Cooperative, Duncan Valley Electric Cooperative, Mohave Electric Cooperative, Graham County Electric Cooperative, and Anza Electric Coop. (Anza is in California), Sierra Southwest Electric Power Cooperative Services, Inc. (the retail sales arm of AEPCO)

[4] Publicly owned: Ak-Chin Electric Utility Authority, Electrical Districts 2, 4, and 5 in Pinal County, the cities of Fredonia, Mesa and Safford, the towns of Thatcher and Wickenburg, the Page Electric Utility, Tohono O'Odham Utility Authority, Navajo Tribal Utility Authority, Hohokam and Wellton-Mohawk Irrigation and Drainage Districts, and the Tonopah Irrigation District. Cooperatives: first five companies in note 1, Columbus Electric Cooperative, Continental Divide Electric Cooperative, Dixie Escalante Rural Electric Association, Garkane Energy Cooperative, and Navopache Electric Cooperative. Federal: U.S. Bureau of Indian Affairs: San Carlos Project and Colorado River Indian Irrigation Project

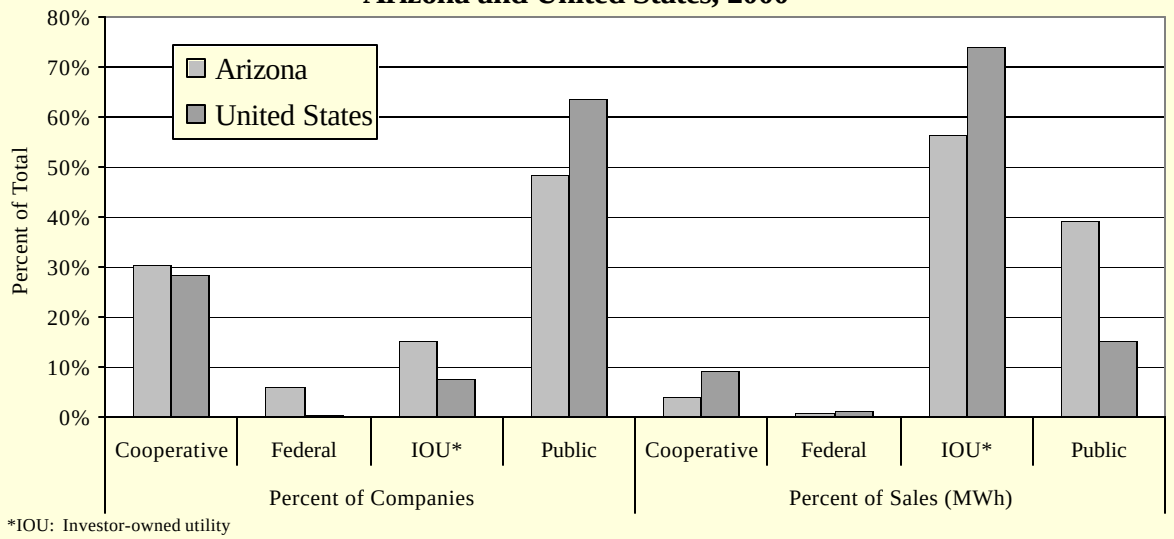
Morenci is a wholly owned subsidiary of Phelps-Dodge, and serves the town of Morenci and the electrical needs of Phelps-Dodge's copper mining operations. Ajo serves approximately 1,000 customers in the town of Ajo in Southwestern Arizona. Although neither Ajo nor Morenci have more than 3,000 customers, the extremely large electricity demands of copper mining and processing make Morenci the state's fourth-largest utility based on megawatt-hour sales.

Electric Utility Ownership

Of the 33 utilities providing power to Arizona customers in 2000, 16 are publicly owned, five are investor-owned, 10 are cooperatives, and two are federally owned. Based on the number of companies operating in the state, Arizona has a larger share of investor-owned utilities and a smaller share of publicly owned and federal utilities than the national average. Arizona is slightly above the national average for cooperatives.

Looking at market share based on total sales, the picture changes. Because Arizona is home to SRP, the fourth largest publicly owned utility in the nation, when market share is calculated based on megawatt hours sold, the market share for publicly owned utilities exceeds the national average, and the shares for IOUs and cooperatives are less than the national average. Figure 2 shows market share by sales and by number of companies for the US and for Arizona.

Figure 2
Electric Utility Market Share By Ownership
Arizona and United States, 2000



*IOU: Investor-owned utility
Source: Energy Information Administration, Form EIA-861, "Annual Electric Utility Report", 2000

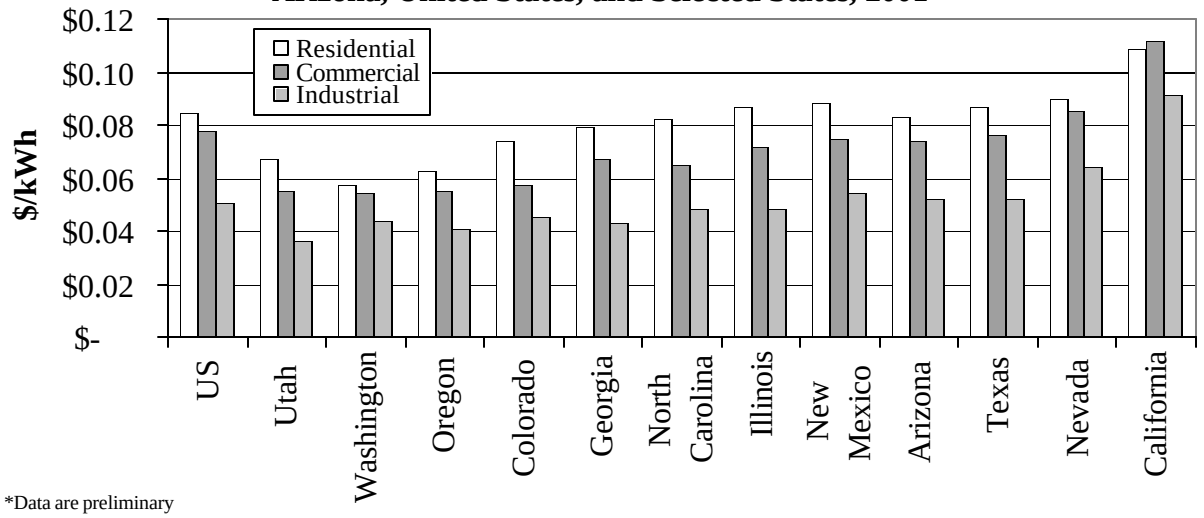
Average Electricity Prices

In the year 2001, Arizona's electricity customers paid rates that were similar to the national average. Figure 3 shows average cents per kWh in 2001 for Arizona, the nation, and several states that compete with Arizona, broken down by sector.

Overall, Arizona residents and businesses paid an average of 7.2 cents per kilowatt-hour. Arizona had the 16th highest average electricity price in the nation, behind the six New England states, the Mid Atlantic states of New York, New Jersey, and Pennsylvania, the Pacific states of California, Alaska and Hawaii, Texas, Florida, and Nevada. Figure 3 shows average prices by sector for states that often compete with Arizona for new business locates. The states are ordered from lowest to highest by average total price. In

2001, Arizona's average total price was the same as the national average and the fourth highest in the West, behind California, Nevada, and Texas.

Figure 3
Average Revenue Per kWh By Sector:
Arizona, United States, and Selected States, 2001*



*Data are preliminary
Source: Energy Information Administration, *Electric Power Monthly*, March 2002.

In Arizona, climate plays a role in increasing average energy prices. The hot Arizona climate drives air conditioning demand, increasing the commercial and residential shares of total sales and reducing the industrial sector's share of total sales. Arizona's residential sales as a percent of total electricity sales are the fourth highest in the nation, behind Florida, Pennsylvania, and South Dakota. Arizona sells 41% of its electricity to the residential sector, compared to 36% nationally.

Since residential customers pay the highest prices, this disproportionately high level of sales in the residential sector raises the average price for electricity for Arizona. Arizona also ranks very low in terms of share of electricity sales to the industrial sector. This also works to raise the average electricity price, since industrial customers pay the lowest price of all three sectors. With only 20% of sales to industrial customers, Arizona ranks 43rd in the nation, and well below the national average of 31% of total sales to industrial users.

Besides causing sectoral usage differences, Arizona's hot weather also works to decrease the load factor in the state.[5] In general, as a utility's load factor falls, its average cost rises. Arizona utilities are also faced with slightly above-average fuel costs, further raising costs.[6]

Electric rates in Arizona are competitive with those in the rest of the nation. For residential customers, Arizona's average price of 8.3 cents/kWh was the 21st highest in the nation, and was lower than the

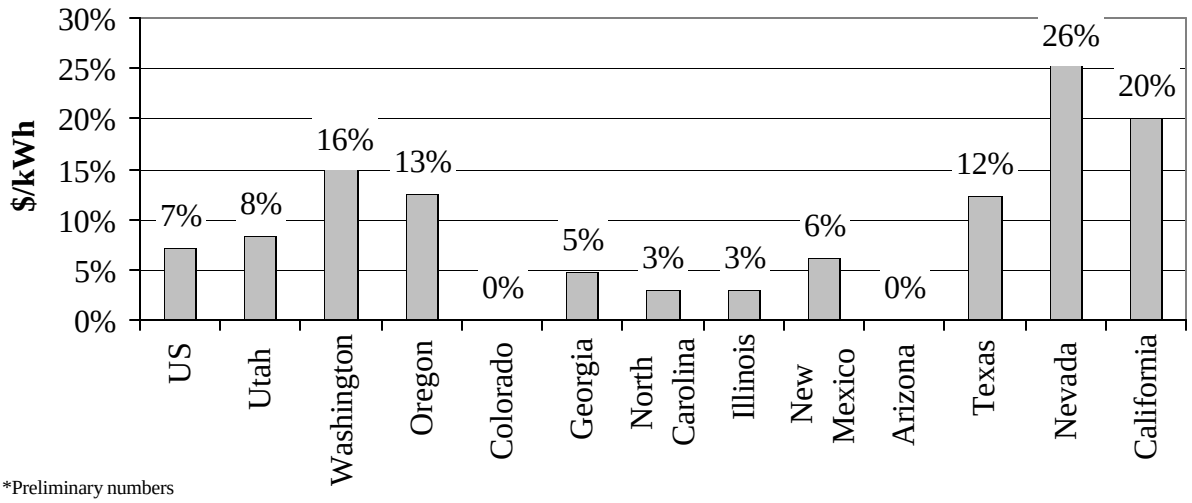
[5] The load factor is the ratio of total sales to peak day demand multiplied by the number of hours in the year. This ratio gives a proxy for "unused resources;" utilities must be able to provide enough energy to meet maximum demand, but if the maximum demand day is very different from the "average" demand day, utilities are faced with generating resources that are not used for much of the year.
[6] In 1999 Arizona's electric utilities paid 9 percent more for coal and 2 percent more for natural gas than the national average. Source: US Department of Energy, Energy Information Administration, *State Energy Price and Expenditure Report*, 1999.

national average price of 8.5 cents. At 7.4 cents/kWh, Arizona's commercial average prices were also lower than the national average of 7.8 cents/kWh, ranking Arizona 20th highest in the nation. For industrial sales, Arizona had the 17th highest average price in the nation. Arizona's average rate of 5.2 cents/kWh was 4% higher than the national average.

In 2001, many of the Western states experienced rapidly escalating electricity prices. There were many causes for this increase, including drought conditions in the Northwest that restricted hydroelectric generation, and higher natural gas prices. In California these conditions were joined with insufficient, aging generation, inadequate gas and electric transmission facilities, and a poorly designed deregulation experiment.

In contrast to much of the rest of the Western United States, most Arizona utilities have either held their rates constant or have decreased rates since 2000. Figure 4 shows the average change in prices from 2000 to 2001 for the United States and selected states.

Figure 4
Change in Total Electricity Prices: 2000-2001
Arizona, United States, and Selected States, 2001*



*Preliminary numbers
Source: Energy Information Administration, *Electric Power Monthly,* March 2002

In much of the West, electricity prices have moderated since 2001, but California's region-high electric rates are expected to persist for many years.[7]

Arizona Generation

Electricity prices tell only part of the story. The events of 2001, with rolling blackouts affecting both California and Nevada, brought home the importance of reliable electricity supplies. Generation is one component of adequate supplies.

[7] Source: California Energy Commission - http://www.energy.ca.gov/electricity/2002-2012_price_forecast.html

Power Plants. As of January 2002, there were 52 power plants operating in Arizona. Thirty-one of these plants were small, with capacity under 100 megawatts (MW). These smaller plants include dams with hydroelectric capacity, solar projects, peaking units designed to meet summer demand for only a few hours per year, or cogeneration or backup units owned by non-utilities. The 21 plants that are larger than 100 MW comprise 96% of the generating capacity currently located within Arizona.[8] The ten largest plants are listed in the table on the next page. By the time this report is released, Pinnacle West's Redhawk Units 1 and 2 will be in commercial operation, adding about 1,000 megawatts of gas-fired capacity.

FIGURE 5

ARIZONA'S TOP TEN ELECTRIC GENERATING FACILITIES BY SUMMER MEGAWATT CAPACITY*
April 2002

Rank	Operator	Plant Name	Fuel	MW	Percent
1	Arizona Public Service Company	Palo Verde	Uranium	3,730	22%
2	Salt River Project	Navajo (SRP)	Coal	2,255	13%
3	U.S. Bureau of Reclamation	Glen Canyon	Water	1,300	8%
4	U.S. Bureau of Reclamation	Hoover AZ	Water	1,042	6%
5	Arizona Public Service Company	Cholla	Coal	995	6%
6	Tucson Electric Power Co	Springerville	Coal	800	5%
7	Salt River Project	Coronado	Coal	760	4%
8	Duke Energy North America	Griffith Energy Project	Gas	620	4%
9	Salt River Project	Agua Fria	Gas	619	4%
10	Reliant Energy Power Generation, Inc.	Desert Basin	Gas	560	3%
			Total, Top 10 Plants	12,682	75%
			Balance of State	4,321	25%
			Arizona Total	**17,002 MW**	

Source: Platt's POWERdat, April 2002, Energy Information Administration

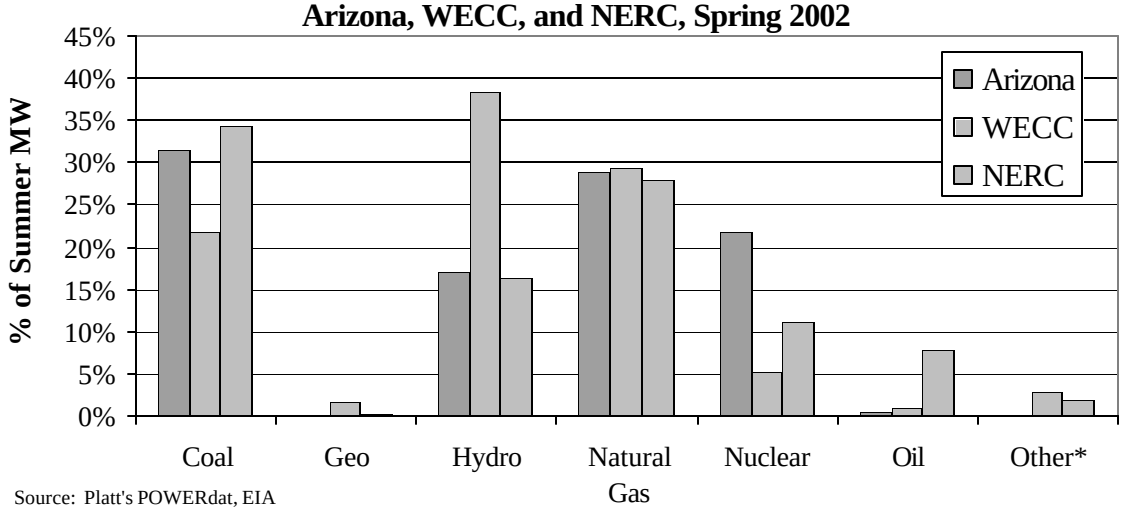
Arizona's three largest utilities operate four of the ten largest plants, and 34 of the 52 plants in the state. Together, these utilities operate 70% of the summer megawatt capacity in the state, or approximately 12,000 MW. Pinnacle West (APS) alone operates approximately 36% of the installed capacity in the state, or approximately 6,000 MW. Salt River Project is second, with 26%, or 4,400 MW. UniSource (TEP) operates about 1,400 MW or 8.5%. Only four other firms operate plants with a capacity that accounts for more than one percent of the state total: Arizona Electric Power Cooperative (AEPCO), Duke Energy, Reliant, and Calpine Mojave. Each of these plants represents approximately 3% of Arizona capacity. AEPCO operates the Apache Power Plant in Southwestern Arizona. The other three plants were constructed as merchant plants. These generators will sell their power into the wholesale market or form contracts for the output from their plants with electric distribution companies in the West. All three of these plants were completed in 2001.

Figure 6 shows the mix of fuels used by generators located in Arizona, in the Western Electric Coordinating Council region (WECC), and the entire North American Electric Reliability Council

[8] Source: Platts POWERdat, 2002

(NERC)[9]. Arizona's installed capacity mix is similar to the nation, with a little over a third of installed capacity generated by coal, a little under a third generated by gas, and approximately 17% generated by hydroelectricity. Arizona is home to the Palo Verde Nuclear Power Station, the largest nuclear generating facility in the United States. Because of the size of this facility, Arizona's share of installed capacity from nuclear generation is over 20%, compared to the national average of just over 10%, and approximately 5% for the WECC. Arizona has significantly less installed capacity than the nation in oil, with less than one percent, compared to almost 8% for the nation. Arizona also has very little installed capacity in alternative energy sources, with 5.3 MW installed, mostly in solar generation.[10]

Figure 6
Summer Generating Capacity by Fuel Type,
Arizona, WECC, and NERC, Spring 2002



Source: Platt's POWERdat, EIA
WECC: Western Electricity Coordinating Council: all of CA, OR, WA, AZ, NV, UT, ID, WY, CO, NM. Part: MT, SD, TX, Canada, Mexico
NERC: North American Reliability Council: the US, parts of Canada and Mexico
*Other includes solar, wind, biomass, wood, and other miscellaneous forms of generation

Because of differences in the way that utilities use their generating units, fuel use as measured by installed capacity (MW) versus fuel use as measured by electricity generated (MWh) are often different. Many of the installed units are used as "peaking" units. These units are used for a comparatively small number of hours per year to meet peak demand. These are typically the least efficient, therefore most expensive, units to operate. These peaking units often use oil or gas as their main fuel. Coal and nuclear units are normally used to serve "base load". Base load units operate around the clock at or close to maximum capacity, thus generating more megawatt-hours in any given year compared to the peaking units. Hydroelectric units tend to fall in the middle, depending on the resource. Some hydroelectric units are operated as peaking units, some are operated year–round as base load units.

When Arizona, the WECC, and NERC are compared based on generation in 2000, the share of generation from "base load" fuels rises relative to the "peaking" fuels. The share of total electricity generated from coal and nuclear sources exceeds the share of installed capacity for these units. Almost half of the

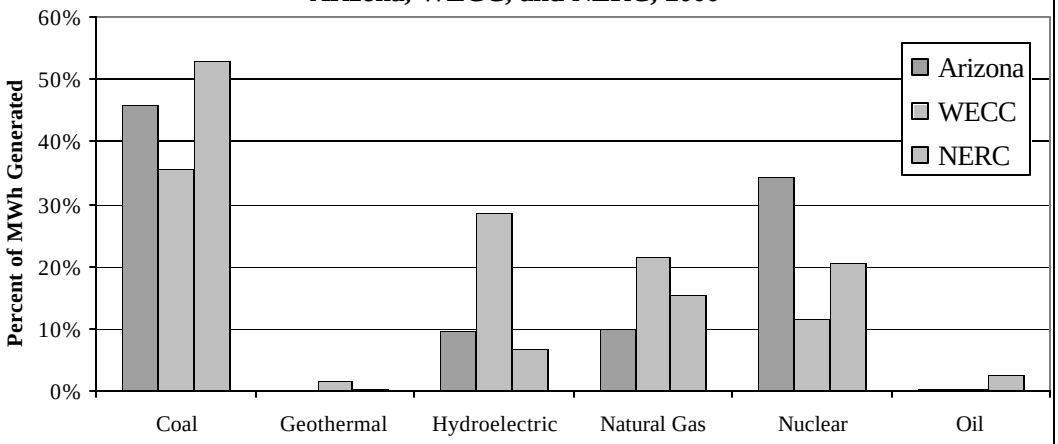
[9] This is the relevant market for Arizona as it represents the states with electrical interconnections to Arizona. The WECC includes: CA, OR, WA, AZ, NV, UT, ID, WY, CO, MT (most), SD (part), parts of Canada and Mexico. The NERC regions cover the entire US as well as parts of Canada and Mexico. This is the relevant electricity market for the United States.

[10] It does not appear that two notable landfill gas projects located in Arizona are included in the Platt's data: the 5 MW generator at the Los Reales Landfill in Tucson and a 4 MW project at the Tri-Cities Landfill in the Phoenix area. These projects are not included in the Arizona total in order to keep regional and national data comparable.

electricity produced in Arizona in 2000 was from coal units, slightly lower than NERC's 53% share, but much higher than the average for the WECC of 36%. Nuclear units accounted for 34% of the electricity generated in Arizona, more than the national average of 21%, and significantly more than the WECC. The wealth of the WECC's hydroelectric resources allowed about a third of the electric ity generated in the region to come from this source. In contrast, Arizona generated 10% of its electricity from hydroelectricity, and the national average was only 7%.

Oil and gas units are often used to meet peak demand and are not operated as continuously as coal and nuclear units. For that reason, the share of electricity generated from these sources is less than the share of capacity installed in all regions. For Arizona, the WECC, and NERC, gas units make up approximately a third of total installed capacity. However, shares of total electricity generated differ greatly across these areas. In Arizona, gas units generated only 10% of total electricity in 2000. The picture is similar for NERC, where gas units generated 15% of total power. For the entire WECC, gas generation was 22% of total generation, significantly higher than either the NERC or Arizona totals. This is largely due to the heavy use of gas units to meet base load generation in California. As with gas, the share of total generation from oil units is significantly less than oil units' share of installed capacity. In Arizona and the WECC, oil is an insignificant share of total generation, at only 0.2%. For the US, oil comprises 3% of total generation. Figure 7 shows generation by fuel type for the WECC, Arizona, and NERC.

Figure 7
Electricity Generated by Fuel Type
Arizona, WECC, and NERC, 2000



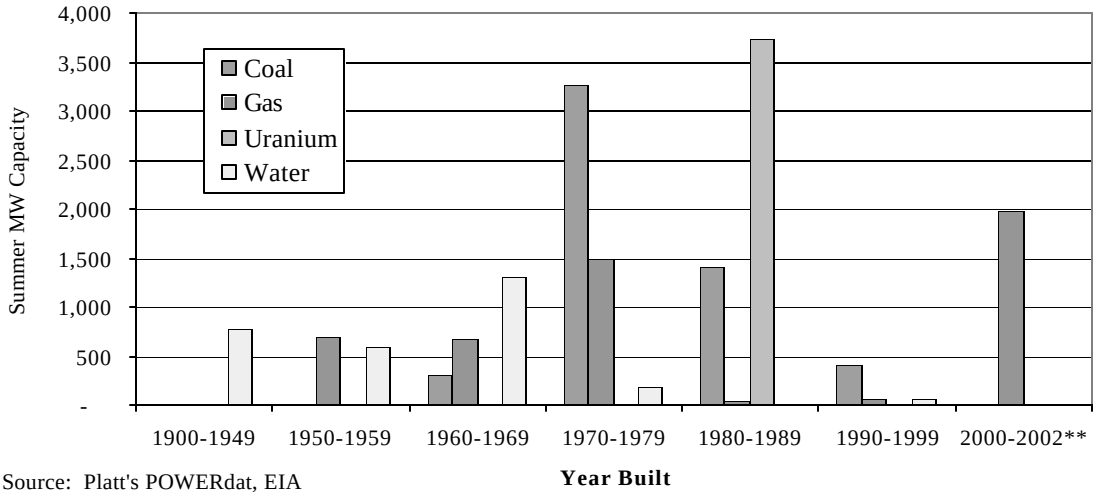
Source: Platt's POWERdat, EIA
WSCC: Western Systems Coordinating Council: all of CA, OR, WA, AZ, NV, UT, ID, WY, CO, NM, Part: MT, SD, TX, Canada, Mexico
NERC: North American Reliability Council: the US, parts of Canada and Mexico
*Other includes solar, wind, biomass, wood, and other miscellaneous forms of generation

The bulk of Arizona's generating plants in service today were built in the 1970s and 1980s. Before 1970, the majority of Arizona's investment in electricity was for hydroelectric resources. The construction boom of the 70s and 80s left the West with enough excess capacity that virtually no construction occurred in the 1990s. Recently, construction of new capacity has picked up as Arizona electricity demand has begun to outpace supply. Figure 8 shows Arizona's existing generation resources by fuel use and year built.

Generation Ownership. Because of the substantial investment involved in building a large power plant and the economies of scale that accompany larger plants, utilities often share the cost, owning only a share of the generation produced from the plant. Five of the 52 plants in Arizona have multiple company

ownership[11]. In many of these cases, some of the co-owners are out-of-state utilities that serve customers outside of Arizona.

Figure 8
Arizona Generating Units By Year Built and Fuel*



Source: Platt's POWERdat, EIA
*Generation from oil and miscellaneous renewable soures are not included because totals are too small to be legible
**As of Spring 2002

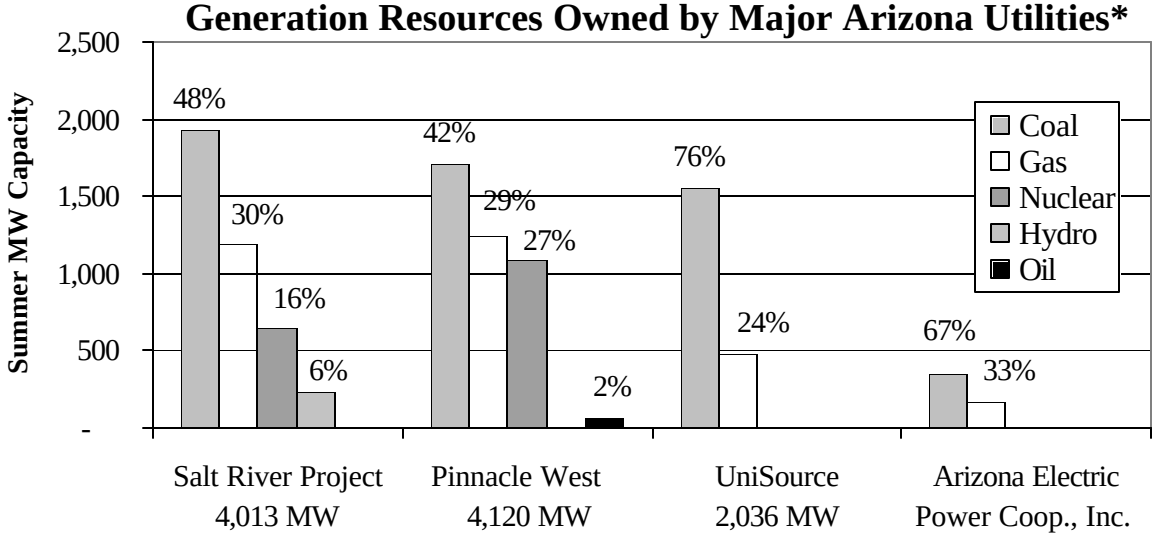
Just as out-of-state utilities own generation resources in Arizona, Arizona utilities own generation resources in other states. Arizona's three major utilities collectively have interests in five out-of-state plants in Colorado, New Mexico, and Nevada for a total of 1,892 MWs.[12]

Figure 9 shows the generation resources by fuel type owned by the four major generation-owning Arizona utilities. Together, these four companies own 10,610 MW of summer capacity and have plans to build another 4,610 MW by 2007. In addition to these resources, many Arizona utilities have contracts for power deliveries with other entities. Twenty-one of the state's electricity providers hold firm contracts for delivery of power from US Bureau of Reclamation hydroelectric projects.

Planned Generation. Federal deregulation of wholesale electricity markets and the California energy crisis have brought significant changes to Arizona's electricity generation market. Strong regional population growth combined with the virtual halt to power plant construction that occurred during the 1990s led to a surge in power plant building activity beginning in 2000. In addition to the almost 2,000 MWs of capacity that were added in 2001, 16,032 MWs of additional capacity have been announced.

[11] Palo Verde (7 owners), Navajo (six owners), Cholla (2 owners), Griffith (2 owners), Yuma Cogeneration (2 owners)
[12] Pinnacle West owns the most out-of-state generation, with 782 MW of New Mexico's Four Corners plant. SRP has 685 MW spread over four plants: New Mexico's Four Corners Plant, Colorado's Craig and Hayden Plants, and Nevada's Mohave plant. UniSource owns interests in the San Juan and Four Corners plants in New Mexico for a total of 424 MWs.

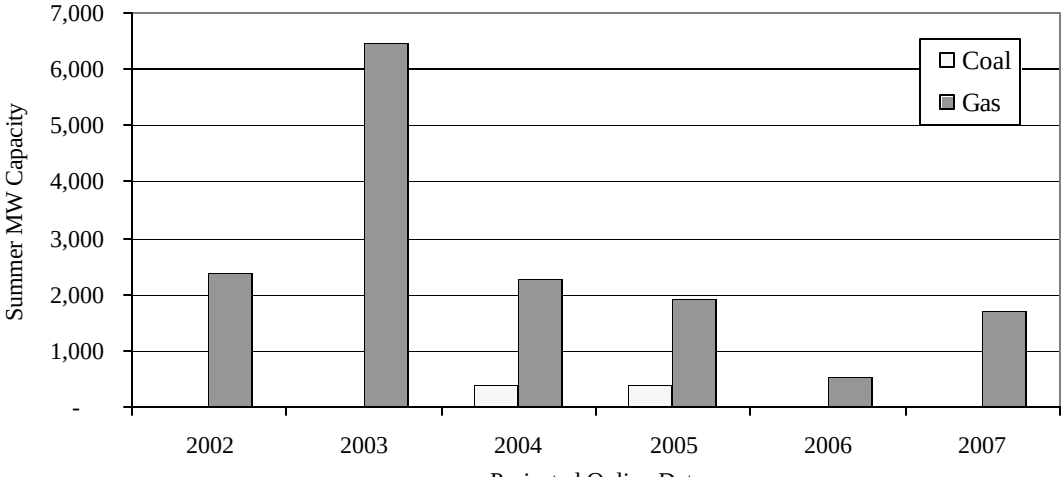
Figure 9
Generation Resources Owned by Major Arizona Utilities*



*Resources operating as of Spring 2002, Source: Platts POWERdat, EIA,

Of the planned plants, 5% of the projects are slated to use coal, and 95% will use gas. Although in the past the primary use for gas plants in Arizona has been as peaking plants, new technologies have increased the efficiency and lowered the cost of gas generation so that many of these new plants will be used to serve base load. This will increase Arizona's use of natural gas in coming years. Figure 10 shows total megawatts announced by projected online date and fuel type.

Figure 10
Planned Generating Units In Arizona
By Projected Online Date and Fuel

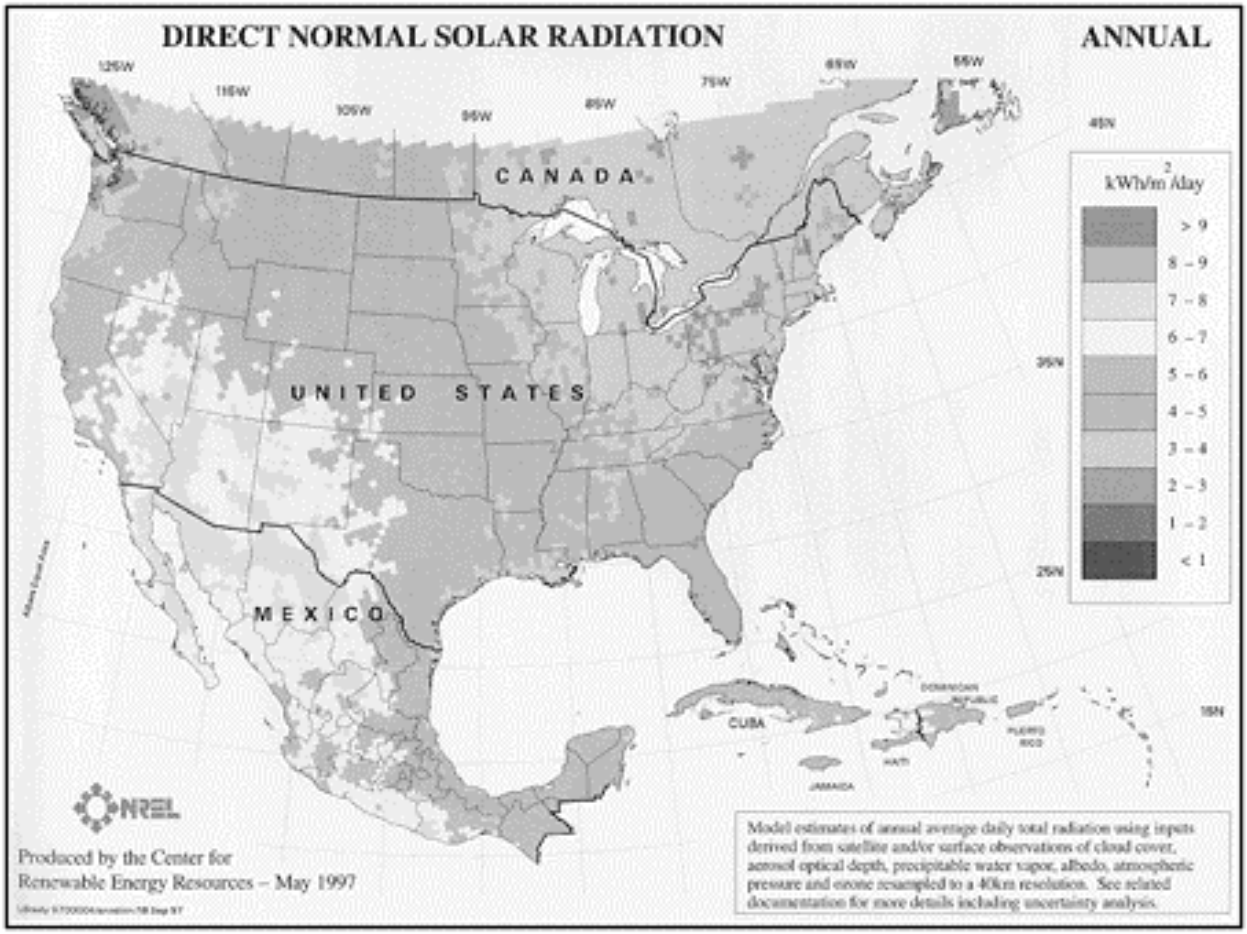


Source: Platt's POWERdat, EIA

Given that Arizona's total installed capacity today is only 17,002 MW, a virtual doubling of capacity by 2007 is unlikely. In all likelihood, not all of the 16,032 MWs that have been announced for completion by 2007 will be constructed. Many of these projects are proposed merchant plants; these are power plants not built by traditional vertically-integrated utilities[13]. These firms would generally sell the generation from their plants into the wholesale market. The electricity produced by these firms could be consumed in Arizona or anywhere in the West.

The three largest Arizona utilities, directly or through affiliates, all have major power plant projects underway. Together, these three firms have 4,610 MWs of capacity planned for completion by 2007. This is 26% of the total that has been announced for Arizona. These increases represent substantial increases in generation capacity for all three firms. Pinnacle West has announced projects totaling 2,610 MW in Arizona, and an additional 570 MW project in Nevada. This 3,180 MWs of additional capacity would increase the generation resources owned by Pinnacle West from 4,040 MW to 7,221 MW; a 79% increase. Salt River Project has announced projects totaling 1,470 MW, a 37% increase from their current capacity of 4,013 MW. UniSource has announced the smallest amount of new generation, with only 531 MWs planned. This would be a 26% increase for the firm, bringing its generation capacity up to 2,567 MW from 2,036 MW. Non-Arizona firms are proposing the remaining 11,422 MW of capacity.

FIGURE 11



[13] A vertically integrated utility is one that owns and operates generation, transmission, and distribution assets in order to deliver power to customers within its service territory.

Renewable Generation Resources. Arizona is not blessed to the same degree as other Western states with significant wind, geothermal, or hydroelectric resources. However, Arizona does lead the nation in potential solar -energy resources (see Figure 11).

Solar electric generating plants cost much more than plants that employ conventional technologies. Large natural gas-fired, combined-cycle plants can be built for less than a million dollars per megawatt, while the best solar technologies still cost four to six times as much (see Figure 12).

FIGURE 12

SOLAR ELECTRIC TECHNOLOGY OPTIONS		
Technology	**Plant Size (MW)**	**Cost ($Million)**
SHS Trough	50	200
Power Tower	15	60
Dish Engine	1	6
Photovoltaic	1	6
Concentrating Photovoltaic	1	6
ORC Trough	1	<5

Source: Presentation by Dr. Peter Johnson, Arizona Public Service, June 2002 [14]

Balanced against the higher capital costs of solar technologies are lower operation and maintenance costs. Fuel is the most expensive component of conventional power generation; sunlight is free. However, a conventional plant can be called on (dispatched) at any time, while solar plants can operate only while the sun is out and generation will be reduced on cloudy days. Because electricity cannot be effectively stored, the inability to dispatch the plant is a significant drawback to solar and wind-powered generation.

Overall, solar electric generation cannot compete yet with conventional plants on pure economics. But solar generation requires no imported fuel, produces no air emissions, and consumes no water. Further, like any newer technology, it is expected that costs will come down as economies of scale are realized and production techniques improve. For these reasons, the Arizona Corporation Commission has initiated an Environmental Portfolio Standard (EPS) for the utilities under its jurisdiction. [15]

Under the EPS, utilities must generate an increasing percentage of their electricity from renewable resources. In 2002, this percentage is 0.4%; by 2007-2012 the percentage increases to 1.1%. 60% of the resource must be from solar with other renewable resources eligible for the remaining 40%. In Arizona, landfill gas, agriculture and forest waste appear to be the leading candidates. APS estimates that the EPS will require the installation of approximately 50 MW of new solar generation in Arizona and approximately 20 MW of other renewable generation.

The EPS is funded through a nominal surcharge on electric bills. For residential customers, the cap is $0.35/month; small commercial customers are capped at $13/month; and large customer will pay no more than $39/month.

By the end of 2002, APS will have installed approximately two megawatts of solar generation. [16] TEP's 1.4-megawatt Springerville Solar Generating Station in Eastern Arizona is the single largest photovoltaic site in the Western Hemisphere. By 2003, the addition of another megawatt will bring TEP's total solar generation to 3 megawatts.[17] TEP also operates a large landfill-gas project with the City of Tucson. [18]

[14] For general information about solar applications in Arizona, visit: http://www.azsolarcenter.com. For detailed information on concentrating solar technologies visit: http://www.energylan.sandia.gov/sunlab/overview.htm; for detailed information on photovoltaic technologies visit: http://www.eren.doe.gov/pv.
[15] See generally http://www.cc.state.az.us/utility/electric/environmental.htm.
[16] See generally http://www.aps.com/my_community/Solar/Solar_29.html and links from that page.
[17] See generally http://www.tucsonelectric.com/community/environment/index.html and links from that page.

APS is also considering several large landfill-gas projects in metro-Phoenix, a significant wind-energy facility near Kingman, and several biogas projects where methane, produced from municipal or animal wasted, would be used to generate electricity.[19]

SRP is not subject to ACC jurisdiction, so the EPS does not apply. Nonetheless, SRP is voluntarily encouraging renewable generation. SRP had committed $29 million over the next four years to support these technologies.[20] In 2001, SRP dedicated a 0.6-megawatt photovoltaic installation at its Agua Fria generating plant.[21] Also in 2001, SRP dedicated a four-megawatt landfill gas generating plant on the Salt River Pima/Maricopa Indian Community.[22]

Finally, solar and other renewable generation have cost-effective applications in remote areas where it may be too expensive to extend a power line. For example, solar energy is being used to power water pumps on ranches, rural streetlights, emergency phones, and entire homes. Solar water heating can be cost effective even in urban areas, particularly in competition with electric water heating. Overall, the next ten years should see substantially increased penetration of solar and other renewable resources into Arizona's generation mix.

Electric Transmission

In addition to generation, there must be adequate transmission lines, substations, and other facilities to deliver the output from a generation plant to market. Further, transmission facilities must be regulated in a manner that allows non-discriminatory access to the facilities by market participants and that encourages the construction of needed transmission additions.

Transmission Regulation. The North American Electric Reliability Council was established in 1968 with the goal of promoting the stability and reliability of the electricity transmission system in the United States and in parts of Mexico and Canada. NERC is composed of ten regional councils organized geographically. Historically, these councils were organized to represent areas of North America that were interconnected by electricity transmission lines.

Arizona is part of the Western Electricity Coordinating Council, an organization that includes electricity generation, transmission, and distribution companies in the West[23]. Because of the interconnectedness of the transmission lines within the WECC, electricity consumed in Arizona can be generated anywhere within the region. For that reason, the WECC is the relevant market to consider when determining the electricity supply and demand balance that will affect prices in Arizona.

The process of moving electricity from power plants to end use customers is divided into two broad categories: transmission and distribution. Transmission refers to the system of high-voltage lines that move power long distances from power plants to the local area in which the power will be sold. The distribution system is made up of lower voltage lines that connect end users to the transmission system.

The transmission system that is in place in Arizona today was designed with the primary goals of connecting Arizona's main load centers[24] with specific generation resources and to allow for the sharing

---

[18] http://www.tucsonelectric.com/Community/Environment/MethaneGas.html.
[19] Source: Presentation by Dr. Peter Johnston, Arizona Public Service, June 2002[19]
[20] http://www.srpnet.com/environment/renewable.asp.
[21] http://www.srpnet.com/power/stations/aguafria.asp.
[22] http://www.srpnet.com/environment/renewable.asp.
[23]The WECC includes: Arizona, California, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming, as well as the Canadian provinces of Alberta and British Columbia, and the northern portion of Baja California Norte, Mexico
[24] A load center is a geographic area in which a large amount of electricity is consumed

of reserves among neighboring utilities[25]. The main load centers in Arizona are the metropolitan areas, primarily Phoenix and Tucson. Arizona's major generation resources are located throughout the Southwest. Although Arizona's transmission infrastructure was not designed with the primary purpose of moving power out of Arizona, interconnections with other states allow Arizona generators to sell excess energy throughout the WECC. Similarly, Arizona utility distribution companies can purchase power generated throughout the WECC and import that power into Arizona.

With the onset of competition in the electric industry, the interconnectedness of the transmission system has become a critical issue. In a regulated marketplace, the electric utility serves a geographic load center and builds a transmission system designed to serve that market. In a deregulated marketplace, merchant generators can serve load in any geographic area that has a connection with their plant. This shift to a competitive paradigm is placing increased demands on transmission systems never designed for these circumstances. Transmission constraints will be discussed further in the next section.

In December of 1999, the Federal Energy Regulatory Commission (FERC) issued Order 2000, calling for formation of Regional Transmission Organizations (RTOs). In this rule, the FERC set forth minimum characteristics of an RTO and required "each public utility[26] that owns, operates, or controls facilities for the transmission of electric energy in interstate commerce make certain filings with respect to forming and participating in an RTO."[27]

RTOs are intended to be independent companies charged with coordinating the delivery of power over the transmission lines within their region. FERC believes that these companies must be independent in order to assure that every company is treated equitably and has equal access to transmission. FERC also believes that the successful implementation of RTOs will lead to efficient development of new transmission assets in the region, as one entity will be better able to plan for regional transmission needs.

There are currently three proposed RTOs in the Western US. All are in partial stages of approval. The California ISO serves California. WestConnect will serve most of Arizona and New Mexico and parts of Colorado, West Texas, and Wyoming. RTO West/TransConnect will serve the rest of the West, including Nevada, Utah, Washington, Oregon, Idaho, parts of Wyoming, and parts of Montana.

The WestConnect RTO represents the culmination of an earlier effort to form a Southwestern RTO known as Desert STAR. WestConnect is still in the organizational stages and is currently awaiting FERC approval of its structure before going forward. Under its current design, WestConnect covers 25,000 megawatts of capacity and six million customers over five states. To date, several transmission-owning entities have expressed interest in participating in WestConnect.

WestConnect will be organized as a for-profit entity, and will exercise functional authority over the transmission assets under its control. The company will be able to acquire and own transmission assets of its own, but will not have to purchase the transmission assets of the participating transmission owners. Under the current structure, companies that maintain ownership of their transmission assets will receive payments from the RTO to compensate them for use of their transmission lines.

The RTO will have independent governance including a board, officers and employees that are not affiliated with the companies that will be buying access on the transmission lines controlled by WestConnect. All market participants will be limited to "passive ownership" as defined by FERC.

---

[25] Reserves are electricity generation resources that are available to be used on short notice. These resources provide backup power in case of outages by the generation resources that are running.

[26] Please note that in this context, "public utility" means "investor owned utility" not public power. Public power, cooperatives, and federal entities are not required to participate in RTOs under Order 2000.

[27] United States of America, Federal Energy Regulatory Commission, 18 CFR Part 35, Docket No. RM99-2-000; Order No. 2000, Regional Transmission Organizations, December 20, 1999, p. 1.

The FERC is currently reviewing WestConnect's request, and approval is expected in the summer of 2002. Pending regulatory approval, the RTO should begin staffing in 2003 and expects to be operational by March of 2004.[28]

Transmission Constraints. The adequacy of transmission infrastructure is a nationwide concern. According to the President's National Energy Policy, released in May 2001:

> "Our nation's most pressing long-term electricity challenge is to build enough new generation and transmission capacity to meet projected growth in demand. … [E]ven with adequate generating capacity, we do not have the infrastructure to ensure reliable supply of electricity. …"
>
> "The price spikes in the Midwest in the summer of 1998 were in part caused by transmission constraints, which limited the region's ability to import electricity from other regions at a time of high demand. Transmission bottlenecks contributed to the blackouts in California over the past year, and have been a persistent cause of price spikes in New York City during peak demand. Constraints on New England's ability to import low-cost power from Canada could raise electricity prices during periods of high demand."[29]

The Edison Electric Institute, the electric industry's think-tank concurs: "Between 1999 and 2000, transmission congestion, as measured by NERC, grew by more than 200 percent. In the first quarter of 2001, transmission congestion was already three times the level experienced during the same period in 2000."[30]

The West is not exempt. The Western Governors stated that wholesale competition underscores "the critical role transmission plays in ensuring reliable safe and economical electric service. Strong transmission systems are key to the development of robust competitive wholesale generation markets."[31]

Arizona is considering, and more importantly, beginning to address these difficult issues. As an example, according to a statewide assessment conducted by the Utilities Division staff of the Arizona Corporation Commission (ACC) in 2001,

> "…the State of Arizona does not have adequate existing or planned transmission facilities to deliver the energy needs of the state in a reliable manner. The planned transmission enhancements are both inadequate and untimely. These conclusions are based upon the following findings:
>
> - There is very little additional long-term firm regional transmission capacity available to export energy over Arizona's transmission system.
>
> - Southeastern Arizona utilities rely upon restoration of service rather than continuity of service following transmission outages due to service via radial transmission lines

[28] Charles Reinhold, *West Connect RTO*, Presentation to the *Arizona Energy Summit*, May 3, 2002, Phoenix, Arizona, http://www.azchamber.com/commerce/2002_Energy_Summit/energy_index.shtml.
[29] National Energy Policy, *Report of the National Energy Policy Development Group*, May 2001, pp. 1-5 - 1-6.
[30] Edison Electric Institute, *Getting Electricity Where It's Needed: Electric Transmission Systems: Making the Vital Link to Customers*, June 2001.
[31] Western Governors' Association, *Conceptual Plan for Electricity Transmission in the West*, August 2001, p. 6.

- There are transmission import constraints for three geographical load zones in Arizona: Phoenix metropolitan area, Tucson, and Yuma. Planned transmission enhancements fail to resolve this situation in a timely manner

- The existing and planned additions to the Palo Verde transmission system fail to accommodate the full output of all new power plants proposing to interconnect at Palo Verde Requiring (sic) curtailment and scheduling restriction procedures to be developed

- Some proposed power plants are being interconnected to Arizona's bulk transmission system via a single transmission line or tie rather than continuing Arizona's best engineering practice of multiple lines emanating from power plants."[32]

Each of these issues identified by the ACC will be discussed in the following sections. By focusing on Arizona's specific issues, it is not intended to imply that Arizona's transmission constraints are out of the ordinary. [33] In recent years, transmission constraints have been responsible for price spikes or blackouts in California, the Midwest, and the Northeast.[34]

Shortage of Export Capacity. Based on 2000 data, the ACC's staff asserted that there was very little long-term firm export capacity available for power moving in and out of Arizona from other states. For example, the ACC staff identified that Arizona's export capacity was limited to 762 MW on a northern path through Four Corners or 449 MW to the north via the Navajo line. To the west, 236 MW were available for export. This lack of long-term firm capacity makes it difficult for new generators to form long-term contracts for delivery of electricity outside of the state.[35]

Reliability in Southeastern Arizona. The ACC report cited the *Southern Arizona Transmission Study*, which found that Southeastern Arizona is particularly vulnerable to electricity outages due to transmission line failures. This is because this region is served via radial lines and there is little opportunity for switching load to alternate lines in the event of a transmission line failure. These failures have resulted in significant service interruptions that led the customers of Citizens Utilities Company in Santa Cruz County and the City of Nogales to file complaints with the ACC in 1999. In response to these complaints, the ACC ordered Citizens to construct a second transmission line to Nogales by December of 2003.[36] Citizens is currently working with Tucson Electric Power to construct a line that will connect TEP's South Substation in Sahuarita, Arizona to a new substation in the Nogales area.[37] Even with these improvements, the ACC staff remains concerned about reliability in Southeastern Arizona due to the amount of load served via radial lines.[38]

Transmission Import Constraints. There are currently three import-constrained areas in Arizona: the Yuma, Tucson, and Phoenix metropolitan areas. In these areas, peak load energy demand exceeds the capacity of the lines feeding the area. During peak times, the utilities must use local generation to make up the supply shortfall. The Yuma area is served by APS and has a transmission import capability of 175 MW. The Tucson area is served by TEP and has an import capability of 1,350 MW.

---

[32] Asher Emerson and Jerry D. Smith, *Revised Biennial Transmission Assessment 2000-2009: Adequacy of Arizona's Existing and Planned Transmission Facilities*, Arizona Corporation Commission, July 2001, p. iii.
[33] Most of the West's transmission bottlenecks identified in the Western Governors' Study were outside Arizona. The most infamous of these is Path 15, linking Northern and Southern California. WGA Report, p. 22, Figure 6.
[34] National Energy Policy, p. 7-5-7-7.
[35] Emerson and Smith, p. 26.
[36] Emerson and Smith, p. 11-12
[37] Tucson Electric Power web site, "About Tucson Electric Power: TEP—Citizens Transmission Line Project", http://www.tucsonelectric.com/Company/News/TransLine/TransLineInfo.html.
[38] Emerson and Smith, p. 14.

The Phoenix area is served predominately by APS and SRP and has a combined import capability of 7,004 megawatts as of 2001, with APS owning 2,870 MW and SRP owning 4,134 MW. According to the ACC, electric load in the Phoenix area is growing by approximately 500 MW annually.[39]

Both utilities are expanding local generating capacity and adding transmission import capacity. SRP plans to add an additional 1,075 MW of local generation at its Santan and Kyrene plants by 2005. APS's generating affiliate, Pinnacle West will add 530 MWs to the West Phoenix plant by 2003.[40] On the transmission front, SRP and APS are collaborating with TEP and many other Arizona energy concerns to develop the Central Arizona Transmission Study (CATS). The goal of this collaborative regional study is to "develop a high level transmission plan for Central Arizona that maximizes regional benefits, while making efficient use of the existing transmission system."[41]

The CATS study area covers most of central Arizona including the Phoenix and Tucson metropolitan areas. Two projects are currently underway for the Phoenix area. First, SRP and APS are constructing a line that will connect the Palo Verde area power plants to the Southwest Valley. This line is expected to be operational by 2003 and will increase transmission import capability into the Phoenix area.[42] Second, SRP, in conjunction with APS, TEP, and several public power entities, has plans to construct a high voltage line from the Palo Verde area to the Southeast Valley. This line would both add to the import capability of the Phoenix area and provide connectivity to several new power plants located in Central Arizona. This line is expected to be operational by 2006.

Although SRP and APS projections show that planned generation and transmission additions will be adequate to meet projected demands, the ACC's staff has pointed out that any delays in these plans will potentially lead to supply shortages in the Phoenix metro area and may result in service interruptions for Valley customers. The siting of transmission lines often encounters public opposition, delaying construction until public objections can be resolved. The ACC staff noted that these delays could result in supply inadequacies in the short run. The 2001 report concluded: "…the APS and SRP planned transmission system additions for the Phoenix metropolitan area are inadequate and not timely."[43]

In the time since the ACC report was published, new generation and transmission additions have significantly increased the amount of energy that can be imported into the Phoenix area. According to Robert Kondziolka, manager of transmission planning with SRP, these improvements will provide sufficient power to the Phoenix area until 2011. According to Cary Diese of APS, recent generation and transmission additions made by APS will provide sufficient transmission import capacity to serve APS customers in the Phoenix area. The ACC staff is presently conducting its Second Biennial Transmission Assessment that will incorporate these new projects.[44]

Transmission constraints in Yuma are also expected to persist. APS plans additions to transmission in 2006, and will use local generation to resolve any import constraints until that time. Although the ACC staff believes that the planned line to Yuma is not timely[45], other potential opportunities such as new

[39] Emerson and Smith, p. 15-16.
[40] Platts POWERdat
[41] Kelly Barr, SRP, "CATS, Central Arizona Transmission Study", presentation to Arizona Energy Summit II, May 3, 2002
[42] Anonymous, "SRP Proposes New 500kV Transmission Line", *Business Contact: News for SRP Business Customers*, September 2001, p. 1-2
[43] Emerson and Smith, p. 32
[44] Anne Brady, "Ariz Power Companies Charged To Serve Big-City Load Thru 2008," Arizona Republic, July 31, 2002.
[45] Emerson and Smith, p. 32.

power plants being built in the area or improvements to existing transmission lines may relieve constraints in the Yuma area prior to 2006.[46]

In the Tucson area, the import constraint problem is caused by voltage instability. TEP has planned several additions to their system to solve this problem, and has also proposed three additional transmission lines in the Tucson area. Although the ACC staff believes that these additions will resolve Tucson's import constraints, they suggest that significant public opposition to the proposed lines is likely and may cause delays in construction so that these additions will also not be made in time to ensure system reliability.[47] Ed Beck, TEP's supervisor of transmission planning, projects that the Tucson area has sufficient transmission to meet demand through 2008, but public opposition and other factors will make it increasingly difficult to construct additional transmission in the future.[48]

Interconnections in the Palo Verde Area. A large number of the new plants being built in Arizona will be located near the Palo Verde nuclear plant, just to the west of Phoenix. The transmission lines currently located in the Palo Verde area can accommodate approximately 3,360 MW of additional capacity, but 8,192 MWs are currently proposed for the area. If transmission additions are not made, the plants in the Palo Verde area will not be able to operate at full capacity.

Three transmission line additions are currently planned for the Palo Verde area. Two of the lines would connect the Palo Verde area to Western Phoenix and Yuma, helping relieve import constraints in these areas. The third would connect the Palo Verde area to Mexico. With these additions, transmission capacity would be expanded to 6,750 MW. The ACC staff points out that even with all of the proposed additions, transmission capacity is still insufficient to allow the simultaneous operation of all of the proposed power plants.

If all of the proposed plants are complete, the Palo Verde area will be the largest electric generating complex in the United States, with an installed capacity of over 12,000 MW in the immediate vicinity of the Palo Verde plant. The ACC staff suggests that with such a large percentage of the total installed capacity of the state located in such a small geographic area, reliability and security concerns are raised. Because of this, the ACC staff feels that reliability criteria should be stringently applied to generators interconnecting in this region.[49]

New Generation Interconnections. The ACC's Utilities Division staff is concerned that some of the newly proposed generation plants in Arizona are not making use of what the ACC staff believes is the best engineering technology in planning their transmission connections. The ACC staff feels that reliability requires at least two transmission lines or transformer ties from all power plant transmission switchyards. As of June 2001, three proposed plants have only single line connections.[50] The ACC staff feels that single connects compromise the reliability of the system due to potential instabilities that would result from the failure of the line. They would like to see all new plants built with at least two connections to the grid in order to ensure system reliability.

Conclusion. Arizona has enough generation currently under construction to ensure abundant supply of electricity for years to come. However, transmission constraints are an issue that must continue to be addressed. Transmission siting and construction can take three to five years, compared to the two to three years it takes to complete a power plant. Efforts like CATS are intended to identify transmission

[46] Brian Cary, Forecast Consultant, Pinnacle West Energy Corporation, personal interview, July 2002.
[47] Emerson and Smith, p. 32.
[48] Brady, 2002.
[49] Emerson and Smith, p. 36.
[50] Emerson and Smith, p. 10-11. The plants cited by the ACC were the 845 MW Gila Bend plant, the 1,040 MW Harquahala plant, and the 1,250 MW Mesquite Plant.

constraints and work to resolve these problems, but solutions must occur in a timely fashion in order to ensure a healthy and reliable electricity market in Arizona.[51]

Electric Industry Restructuring

In 1998, Arizona passed the Electric Power Competition Act. This legislation was designed to open Arizona's electricity market to competition and complemented administrative rules that were being adopted by the ACC. The legislation's intent was to allow competition in several aspects of the electricity market. Consumers would be billed separately for generation of power, delivery of power, and for other related services like meter reading. The power delivery service was to remain as a regulated monopoly, but other aspects of the electricity industry would be open to competition. As of December 31, 2000, the service territories of most of Arizona's utilities were officially open to competition.[52]

Under the ACC's Electric Competition Rules, adopted in 1999, APS, TEP, and Arizona Electric Power Cooperative were required to separate their generation and competitive power service businesses from their noncompetitive power delivery business. In 1999, Pinnacle West formed Pinnacle West Energy, an unregulated division of the company that will be responsible for the power generation side of Pinnacle West's business. To date, Pinnacle West Energy has constructed new generation but none of the APS generating units have been transferred to Pinnacle West Energy. Pinnacle West also has another subsidiary, APS Energy Services, a regulated Electric Service Provider that is responsible for retail power marketing and other competitive energy services. UniSource, the parent company of Tucson Electric Power, formed Millennium Energy in 1996 as the parent company for UniSource's unregulated businesses. To date, TEP has not transferred its generation to a subsidiary. Pinnacle West has requested the ACC's approval to transfer APS's fossil fuel generation assets to Pinnacle West Energy; this is still an open item at the ACC. UniSource has applied for an extension to December 31, 2003. The ACC is currently reviewing this requirement to determine if divestiture is in the best interest of Arizona's electric customers.

Arizona Electric Power Cooperative (AEPCO) was also required to divest its generation resources. In 1999, AEPCO restructured into three entities: Arizona Electric Power, Sierra Southwest Cooperative Services (SSCS), and Southwest Transmission Cooperative. Arizona Electric Power is responsible for the generation of electricity. Southwest Transmission Cooperative operates the transmission systems owned by AEPCO, and Sierra Southwest is the retail sales arm of AEPCO.

As a public power entity not subject to the ACC's Electric Competition Rules, SRP was not required to divest its generation assets. However, SRP was required to adopt and implement a code of conduct that it must obey. The code of conduct requires public power entities to internally separate the competitive and noncompetitive sides of their business in order to prevent any anti-competitive activities that might result from SRP not divesting its competitive assets. In 1997, SRP founded New West Energy, a private, for-profit, wholly owned subsidiary.

Although Arizona's competitive electricity marketplace is officially open, there has been little activity in terms of customers choosing alternative electricity providers. In order to participate in the competitive retail marketplace, a company must register with the Arizona Corporation Commission and become certified as a retail Electric Service Provider (ESP). As of April 2002, 16 entities were registered as certified ESPs in Arizona. Nine of the 16 registered companies are certified to provide electric generation or aggregation services, including the retail marketing arms of three major Arizona generation owners:

---

[51] Emerson and Smith, p. 37.

[52] Katrina Walls, "Electricity Deregulation in Arizona: Beginnings of A Competitive Utilities Market", Center for Business Research, College of Business, Arizona State University, January 2000; Arizona Corporation Commission; SRP, APS, TEP web sites

SRP, Pinnacle West, and the Arizona Electric Power Cooperative.[53] The other seven companies are certified to provide services related to metering. Of the nine generation and aggregation providers, only the three Arizona companies are certified to provide services to residential customers (APS Energy Services, New West Energy, Sierra Southwest). The other six companies are certified for non-residential customers only.

Although deregulation in Arizona is officially active, for all practical purposes, activity has stalled. Largely due to the difficulties of deregulation in California, consumers are reluctant to switch energy providers for fear of exposure to price swings or outages. For this reason and due to an uncertain regulatory climate, many ESPs have reduced or eliminated their marketing efforts in Arizona until the outlook for electricity markets becomes more stable. APS Energy Services remains very active in gaining new customers and marketing power and other energy services inside and outside Arizona.

Current developments suggest that Arizona has yet to iron out all the details of how its newly structured electricity markets will operate. One critical issue is the requirement that utilities divest their generation assets. In California, where companies were required to divest their generation resources, allegations of market price manipulation by generators during 2000 and 2001 abound. Arizona regulators are now trying to decide if Arizona's restructuring framework would allow similar types of market manipulation to occur in Arizona.

The ACC's Electric Competition Rules require affected utilities to purchase electricity in a competitive market after the divestiture of their generating plants, with at least half through competitive bidding. APS and TEP are currently requesting a partial variance to this requirement so that they would be allowed to purchase a higher proportion of their power from their unregulated generation subsidiaries. Merchant generators that have recently completed plants or are currently building plants in Arizona are opposing this request. These companies claim that allowing variances would effectively bar them from being able to sell electricity in Arizona. The Arizona Corporation Commission is currently studying these and other issues in an assessment of electricity restructuring in Arizona. The ACC expects a decision on power plant divestiture in 2002.[54]

Arizona and Oregon are the only states in the WECC actively pursing restructuring designed to provide retail access[55]. States with an active restructuring process have either enacted enabling legislation or have issued a regulatory order to implement retail access. In these states, retail access is available or will soon be available.[56] Figure 13, from the Energy Information Administration, shows the status of electricity restructuring activities in each state. After the problems related to deregulation that occurred in California during 2000 and 2001, California halted its restructuring process and Nevada, Washington, and Montana delayed their restructuring activities. In states with delayed restructuring activities, retail access may be available to some large customers, but efforts to expand access to smaller customers has been put on hold. In addition to Arizona, deregulation continues to be active in Texas, Illinois, Michigan, and most of the MidAtlantic and New England states.

---

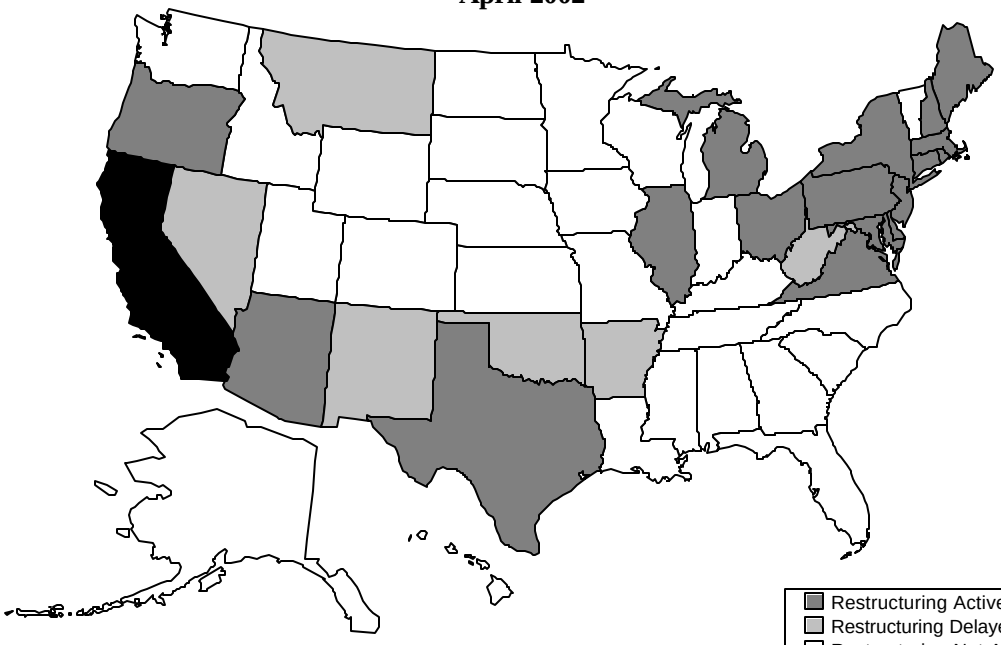
[53] Aggregation services are when a company pools the demands of many small users in order to take advantage of volume discounts in purchasing power. The nine companies were: Sempra Energy Trading Corporation, Enron Energy Services, New West Energy, Sierra Southwest Cooperative Services, APS Energy Services Company, Nevada Southwest, Illinova Energy Partners, New Millennium Energy Corporation, and PDM Energy. Source: http://www.cc.state.az.us/utility/electric/esplist.pdf

[54] Jarman, Max, *Arizona Republic*, "Electric Power Battle Brewing", April 27, 2002

[55] Retail access means end-use customers like residential, commercial, or industrial customers can choose the company from which they purchase electricity.

[56] Source: US Department of Energy, Energy Information Administration, March 2002, http://www.eia.doe.gov/cneaf/electricity/page/restructure.html

Figure 13
Status of Electricity Restructuring
April 2002



Source: US Department of Energy, Energy Information Administration, March 2002, http://www.eia.doe.gov/cneaf/electricity/chg_str/regmap.html

NATURAL GAS

Arizona Natural Gas Providers

The Department of Energy's Energy Information Administration (EIA) collected information on eleven companies that deliver natural gas to customers in Arizona. Figure 14 lists these entities ranked by number of customers.

FIGURE 14

ARIZONA'S MAJOR PROVIDERS OF NATURAL GAS, 2000

Company	Customers	Pct	Volume (Mcf)*	Pct	Average Price ($/Tcf)**
Southwest Gas Corp	727,187	81%	66,200,371	81%	$7.72
Citizens Utilities Arizona Gas Div	105,714	12%	9,616,879	12%	$5.51
City of Mesa	36,492	4%	3,473,414	4%	$7.88
Black Mountain Gas Co	8,019	0.9%	677,405	0.8%	$4.86
Citizens Utilities-Santa Cruz	6,892	0.8%	516,620	0.6%	$6.36
Graham County Utility Inc.	4,671	0.5%	290,559	0.3%	$7.13
Navajo Tribal Utility Authority	4,581	0.5%	697,574	0.9%	$5.84

ARIZONA'S MAJOR PROVIDERS OF NATURAL GAS, 2000

Company	Customers	Pct	Volume (Mcf)*	Pct	Average Price ($/Tcf)**
City of Safford	3,418	0.4%	233,373	0.3%	$10.07
City of Benson	1,935	0.2%	123,925	0.2%	$3.30
City of Willcox	1,393	0.2%	154,744	0.2%	$4.99
Transwestern Pipeline Co	1	0%	24,315	0%	$2.15
Total	900,303		82,009,179		$7.41

Source: US Department of Energy, Energy Information Administration, Form EIA-176, http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html
*Mcf: million cubic feet, **$/Tcf: dollars per thousand cubic feet

Southwest Gas Corporation and Citizens Utilities dominate the natural gas delivery market in Arizona. Together, these two firms serve 93 percent of all customers in Arizona. The City of Mesa serves about 36,000 customers, making it the third largest deliverer of natural gas in the state with a 4% market share. The other Arizona providers serve a small number of customers, with no company making up more than 1% of the total market.

Southwest Gas is an investor-owned utility serving approximately 1.3 million customers in Arizona, Nevada, and Southern California. Due largely to the rapid population growth occurring in its service territory, Southwest Gas is the fastest-growing natural gas distribution company in the United States.[57] Southwest Gas has its service territory in central and southern Arizona, serving parts of WACOG, MAG, CAAG, PAG, and SEAGO.[58] Southwest serves most of MAG, including the Phoenix metropolitan area excluding parts of Mesa, and most of PAG, including the Tucson metropolitan area. Southwest serves most of Pinal and Cochise counties, and about half of Yuma County including the Yuma area. Southwest has a small amount of territory in Graham and Greenlee counties.

Southwest serves 81 percent of all residential, commercial, and industrial customers in Arizona. By class, Southwest serves 81% of Arizona's residential customers, but only 72% of the commercial customers and almost 93% of the industrial customers. The disproportionately large share of industrial customers reflects the fact that Southwest serves the two major metropolitan areas of Arizona.

Citizens Utilities Company is an investor-owned utility with both gas and electric customers in Arizona. Citizens serves WACOG, NACOG, and SEAGO, with most of its service territory and customers in Northern Arizona.[59] Citizens serves all of Yavapai and Coconino counties, and most of Navajo county.[60] A small number of customers are located in Santa Cruz County. Citizens' two Arizona divisions collectively serve 12 percent of Arizona's residential customers, almost 6% of the industrial customers, and almost 20% of the commercial customers. As with its electricity business, Citizens Communications Company is currently seeking to sell its natural gas division. To date, no buyer has been announced.

[57] Southwest Gas Website, May 2000, http://www.swgas.com/corp/index.html
[58] WACOG: Western Area Council of Governments: Yuma, Mohave, and La Paz counties; MAG: Maricopa Association of Governments: Maricopa County; CAAG: Central Arizona Council of Governments: Pinal and Gila counties; PAG: Pima Association of Governments: Pima County; SEAGO: Southern Arizona Council of Governments: Cochise, Santa Cruz, Graham, and Greenlee counties
[59] NACOG: Northern Arizona Council of Governments: Apache, Coconino, Navajo and Yavapai counties
[60] Although Citizens' official territory covers part of Apache County, Citizens does not currently have any customers in Apache County

The City of Mesa serves 4% of the state's residential customers, almost 5% of the commercial, and almost 1% of the industrial customers. Together, these three utilities account for 96% of the residential, 95% of the commercial, and 99% of the industrial customers in Arizona.

Graham County Utilities is a nonprofit cooperative serving most of Graham County. Black Mountain Gas Co is a subsidiary of Minnesota-based Xcel Energy and serves the Carefree and Cave Creek areas in northern Maricopa County. The Navajo Tribal Utility Authority serves the Navajo nation in the northern parts of Apache and Navajo counties. The remaining entities are municipal utilities: the cities of Mesa, Safford, Benson, and Willcox.

Natural Gas Prices[61]

Arizona residential gas customers pay an average price of $9.43 per thousand cubic feet for natural gas, well above the national average of $7.76. Arizona has the 12th highest price for natural gas in the nation. Arizona's average price is high because, as a result of Arizona's warm climate, most Arizona residents consume relatively little gas for space heating. Consequently, the fixed costs to construct, operate and maintain distribution facilities must be recovered over fewer cubic feet of gas consumed. Also, because of Arizona's rapid, recent growth, Arizona's gas infrastructure is newer and, thus less depreciated. Therefore, the dollar ratebase per residential customer is relatively higher in Arizona. California, which also has a temperate climate and relatively low residential consumption, is the next-highest priced Western state with residential prices averaging $8.21 per thousand cubic feet.

Arizona's commercial and industrial customers pay prices that are close to the national average. At $6.69 per thousand cubic feet, Arizona's commercial customers pay prices that are only slightly above the national average of $6.59 per thousand cubic feet. Arizona has the 23rd highest average commercial price in the continental US. As with residential prices, most of the states with the highest commercial prices are in the East, with the New England states of Massachusetts and Rhode Island having the highest prices. The lowest commercial prices in the nation are in the Midwest and West, with Michigan and New Mexico having the lowest average commercial prices in the contiguous US.

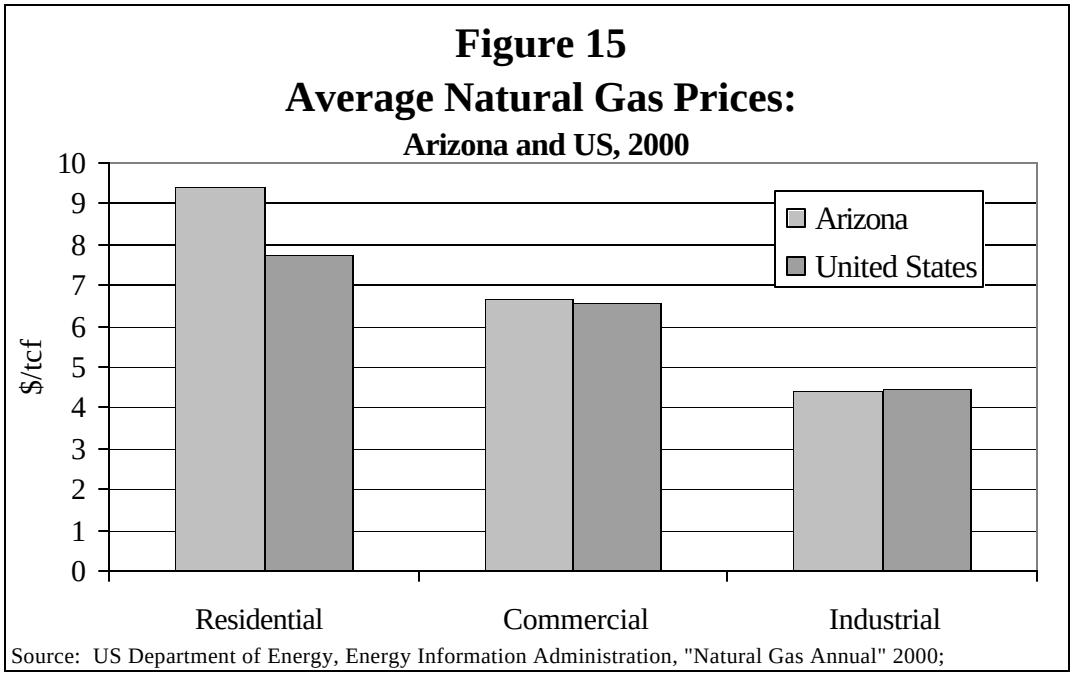
Industrial consumers in Arizona pay an average price of $4.40 per thousand cubic feet, slightly below the national average of $4.48. Arizona's industrial customers pay the 35th highest prices in the nation. Of the 15 with lower average industrial prices, most of them were in the West and Midwest. Figure 15 shows average natural gas revenues per thousand cubic feet by sector for Arizona and the United States in 2000.

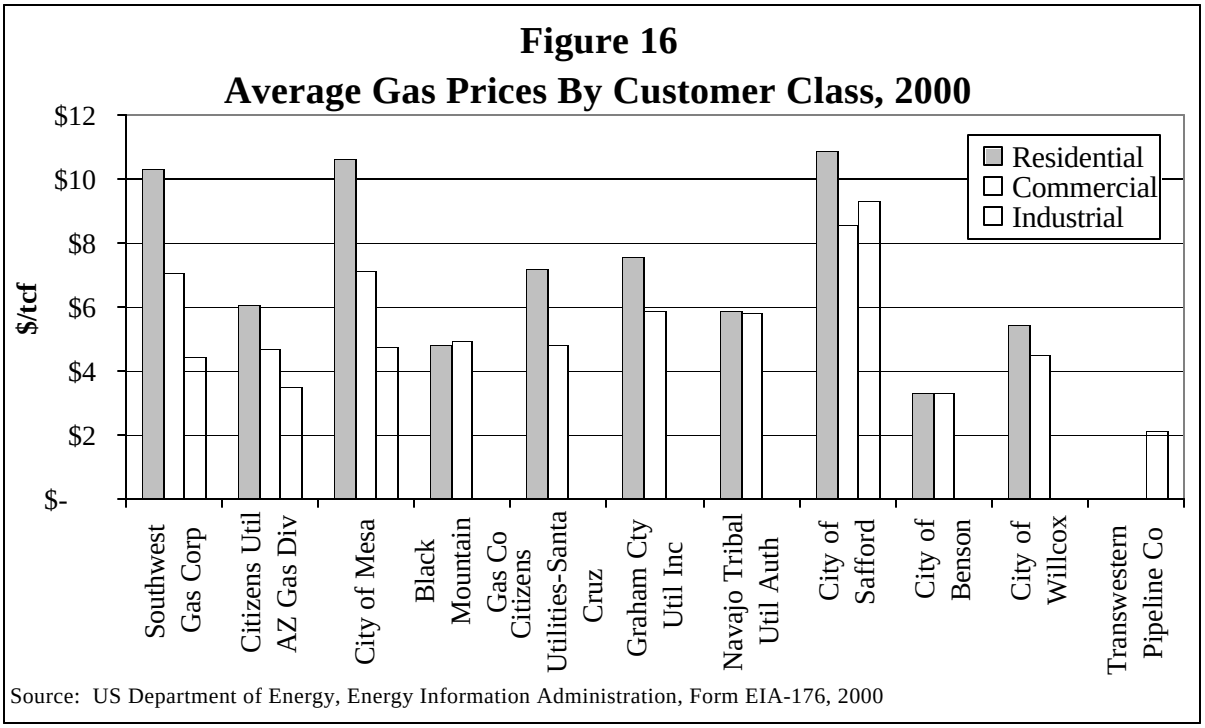
Natural Gas Prices by Distribution Company

The average natural gas price paid by any given consumer in Arizona depends not only on the sector a consumer is in but also where that consumer is located in the state. Figure 16 lists average natural gas prices by sector for each Arizona distribution company that the Department of Energy had information for in 2000. Overall, the Transwestern pipeline company had the lowest average price, at just $2.15 per thousand cubic feet. However, since Transwestern served only one industrial customer, its average price is misleadingly low. The City of Benson had the next lowest average price, at $3.30. The highest price was charged by the city of Safford, at $10.07. Figure 16 shows average price by customer class for the eleven entities with residential, commercial, or industrial customers in 2000.[62]

[61] All data from US Department of Energy, Energy Information Administration, Form EIA-176, http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html

[62] US Department of Energy, Energy Information Administration, Form EIA-176, http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html





Overall, Safford had the highest prices in all categories, and the City of Benson had the lowest prices in all categories except industrial, where Transwestern was lowest. Residential customers in Arizona faced average prices that ranged from $3.30 in Benson to $10.89 in Safford. Three utilities had residential

prices over $10: Southwest Gas, the City of Mesa, and the City of Safford. Another four had prices under $6: the City of Benson, Black Mountain Gas Company, the City of Willcox, and the Navajo Tribal Utility Authority.

Commercial customers paid average prices ranging from $3.30 to $8.55. The highest priced utilities were again the cities of Safford and Mesa and Southwest Gas, with all three having prices above $7. Four utilities had prices under $5: the cities of Benson and Willcox, Citizens (both divisions), and the Black Mountain Gas Company.

Only five of the utilities served industrial customers, with average prices ranging from Transwestern's $2.15 to $9.33 in Safford. The remaining three utilities charged more average prices in the $3.50-$4.50 range.

Natural gas prices have experienced volatility in recent years, leaving both consumers and natural gas distribution companies facing uncertain energy costs. In an attempt to reduce this volatility, in 1998 the Arizona Corporation Commission (ACC) studied the Purchased Gas Adjustment (PGA) mechanism that Arizona natural gas distribution companies were using and recommended changes that were intended to reduce price volatility faced by consumers. Before 1998, the natural gas distribution companies charged consumers for delivery of gas and for the gas commodity cost. The price consumers paid for distribution was divided into two parts: the price of delivering the gas from the city gate to the consumer, and the cost of the actual gas consumed plus the transmission cost associated with bringing that gas to the city gate. The second part was regulated through the PGA. If the prices that distribution companies paid for the gas they delivered changed significantly, these companies would apply to the ACC for a change to the PGA.[63] In late 1998, ACC adopted a different version of the PGA based on a 12-month rolling average of past prices. This rolling average would be banded to protect consumers from large swings in prices. Distribution companies would have accounts that would be in debit or credit depending on where the actual gas prices were relative to the PGA price.[64] The PGA's that are currently in force for the gas distribution companies that are regulated by the ACC are now posted on the ACC's web site and updated monthly.[65]

Natural Gas Transmission and Storage

The transmission of natural gas involves the movement of gas long distances over high-capacity pipelines. There are two natural gas transmission companies operating pipelines in Arizona: the Transwestern Pipeline Company and El Paso Natural Gas.

Transwestern is a subsidiary of Enron Corporation and operates an east-west pipeline in Northern Arizona running across the state through Window Rock, Flagstaff, and Kingman, and into California. El Paso operates pipelines in both the northern and southern parts of the state. In the south, the system goes through Willcox, Tucson, Casa Grande, and Ehrenberg, with extensions to Nogales, Safford, Globe, Phoenix, and Yuma. In the North, El Paso's system parallels Transwestern's. Both systems continue into California to feed the Southern California area.[66]

An increase in demand for natural gas due to population growth and a recent boom in the construction of natural-gas fueled electric power plants has led to concerns about available capacity on these pipelines.

---

[63] Arizona Corporation Commission, *Staff Report on Purchased Gas Adjustor Mechanisms*, October 19, 1998, http://www.cc.state.az.us/utility/gas/staffpga.pdf

[64] Arizona Corporation Commission, Docket Number G-00000C-98-0568, October 30, 1998, http://www.cc.state.az.us/utility/gas/61225.pdf

[65] Arizona Corporation Commission, "Monthly Purchased Gas Adjustor Rates for Arizona Natural Gas Distribution Companies", April 2002, http://www.cc.state.az.us/utility/gas/index.htm

[66] Arizona Corporation Commission, *Staff Report on Purchased Gas Adjustor Mechanisms*, October 19, 1998, p. 5, http://www.cc.state.az.us/utility/gas/staffpga.pdf

The Transwestern pipeline is fully subscribed for Western deliveries through 2005. Enron has proposed an expansion of this pipeline, called the Sun Devil Pipeline. The new capacity would serve the Phoenix and Southern California markets. In the initial open season held in September 2001[67], Transwestern received about 1.3 billion cubic feet per day in requests for capacity on the new line. The project is still in the planning phase of development.[68]

The El Paso system is also fully subscribed. Currently, demand for gas from the El Paso system has been so strong that FERC has been asked to step in and settle contract disputes resulting from curtailments for "full requirements" customers. Natural gas transmission contracts have historically fallen into two main categories: contract demand and full requirements. Contract demand customers contract with the transmission company for a fixed quantity over a set time period. Full requirements customers contract for delivery of whatever their needs are over some time period. Many of El Paso's customers in Arizona, including companies that deliver natural gas and electricity to Arizona customers, are full requirements customers that have faced curtailment due to capacity constraints in the pipeline system. In response to forecasts that project more curtailments in the future, FERC has ordered that all customers be converted to contract demand customers. Many Arizona customers of El Paso feel that the contract levels resulting from this settlement could lead to natural gas shortages for residential and electric power plant customers in Arizona.[69]

Natural gas can be stored underground in abandoned gas fields or in excavated salt formations. Storage allows gas to be injected into the ground during times of low demand and prices, for withdrawal during times of higher demand and prices. Storage also allows better balancing of loads, particularly in response to shifting demands as gas-fired power plants follow electricity demand. Unlike many western states, Arizona lacks gas-storage facilities, but several are being considered.

A gas pipeline and storage project has been announced by a group of three energy companies. Allegheny Energy Supply Company, Salt River Project, and Sempra Energy Resources are proposing the Desert Crossing Pipeline. The storage facility will be located in the Hualapai Valley north of Kingman, Arizona. The pipeline will be an 800 million cubic feet per day system from Las Vegas to Southwestern Arizona that will connect major interstate pipelines in Arizona and Southern Nevada. The pipeline's north-south alignment will give Arizona consumers another option in natural gas transmission and should help to relieve the capacity constraints that the current system is facing.[70]

On August 9, 2002, Red Lake Gas Storage, L.P., an affiliate of Aquila, Inc., filed an application with the Federal Energy Regulatory Commission for authorization to construct and operate a gas storage project in Mohave County, north of Kingman, Arizona.[71] Red Lake plans to excavate a salt-dome formation and construct associated facilities to provide storage for up to 12 billion cubic feet of natural gas. Plans for the Red Lake facility include 21 miles of additional pipelines for interconnection near Kingman with interstate natural gas pipelines owned by El Paso Natural Gas Company, Transwestern Pipeline Company, and Southern Trails Pipeline. Assuming prompt FERC approval, Red Lake plans to commence service in late 2003.

---

[67] During open season, a pipeline company will solicit requests for capacity on the new line from potential customers.

[68] Enron Corporation Press Release, "Transwestern Pipeline Announces Successful Open Season for Proposed Sun Devil Pipeline Expansion", September 10, 2001, http://www.enron.com/corp/pressroom/releases/2001/ene/Transwestern.html

[69] Bryan Lee, "US FERC Wrestles With Demands For Gas On El Paso System," Dow Jones Energy Service, Dow Jones Newswires, 4/16/2002

[70] Press Release, "Allegheny Energy Supply Company, SRP and Semipro Energy Resources Announce Open Season for Proposed Desert Crossing Gas Storage and Transportation System", Jan 10, 2002, http://www.desert-crossing.com/media/presrel.htm

[71] Notice of Application dated August 21, 2002.

Several other natural gas projects have been proposed for Arizona. Power up is proposing a pipeline from the Four Corners area south along the Arizona-New Mexico border to the El Paso Southern pipeline alignment and then west into Arizona turning north into Central Arizona west of Willcox. This project is slated for completion by 2004 and is intended for power plants rather than retail consumer service. There is a storage facility being planned for western Maricopa County called Copper Eagle Gas Storage. The Questar Southern Trails pipeline located in northern Arizona was to begin commencing service in June 2002.[72] Finally, Pacific-Texas Pipeline & Transportation Company has proposed an 800-mile, 36-inch pipeline from the West-Texas Hub, to Blythe, California, called the Picacho Pipeline.[73]

It is beyond the scope of this report to forecast or handicap which projects may actually be constructed. The FERC-approval process typically takes two to three years, and capital must be raised. However, it is encouraging that Arizona is attracting investor interest.

Natural Gas Unbundling

Many states have recently moved towards separating natural gas delivery services from the sale of natural gas. This separation is known as unbundling. With unbundling, consumers are allowed to choose their natural gas energy provider in a competitive marketplace. Natural gas delivery service remains a regulated monopoly.

As of December 2001, five states and the District of Columbia had 100% eligibility and statewide unbundling. In these states, all consumers have choice of natural gas provider. Seven more states had completed unbundling but are still in the implementation stage, and have not yet granted full choice to all consumers in the state.[74] Eight states have pilot programs underway, and two more states, Delaware and Wisconsin, have pilot programs that are currently suspended.[75]

Of the other 28 states that have not implemented unbundling legislation, ten are considering implementing unbundling, and 18 are not. Arizona does not currently have any form of unbundling legislation in place and is not considering implementing legislation.[76] However, large customers can and do buy direct from suppliers and ship on the interstate pipeline system. This is a federal right. Large customers are effectively unbundled already. Figure 17 shows the status of natural gas unbundling by state as of December 2001.[77]

PETROLEUM

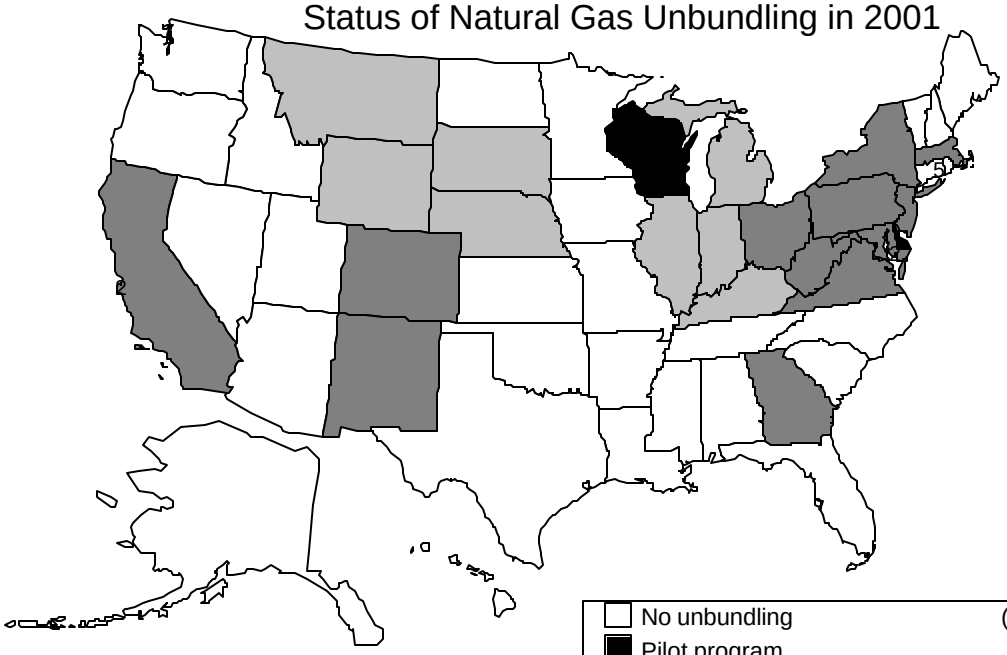
Consumption

Petroleum products are used throughout the economy, but their main use is for transportation. Figure 18 shows per capita petroleum usage by end use sector. For both Arizona and the United States, transportation is by far the major use for petroleum products. In Arizona, the transportation sector uses almost 88 percent of the petroleum products used in the state, compared to 66 percent nationally.

---

[72] Jerry Smith, Arizona Corporation Commission, July 2002.
[73] Jarman, Max, *Arizona Republic* "Plan could bring Texas gas to Ariz. in pipelines", May 28, 2002. http://www.pacifictexas.com/.
[74] The states with 100% eligibility are NJ, NM, NY, PA, and WV. States still in implementation: CA, CO, GA, MD, MA, OH, and VA.
[75] The states with pilot programs are IL, IN, KY, MI, MT, NE, SD, WY
[76] The states considering programs are: IA, KS, ME, MN, NV, NH, OK, SC, TX, VT
[77] US Department of Energy, Energy Information Administration, http://www.eia.doe.gov/oil_gas/natural_gas/restructure/restructure.html

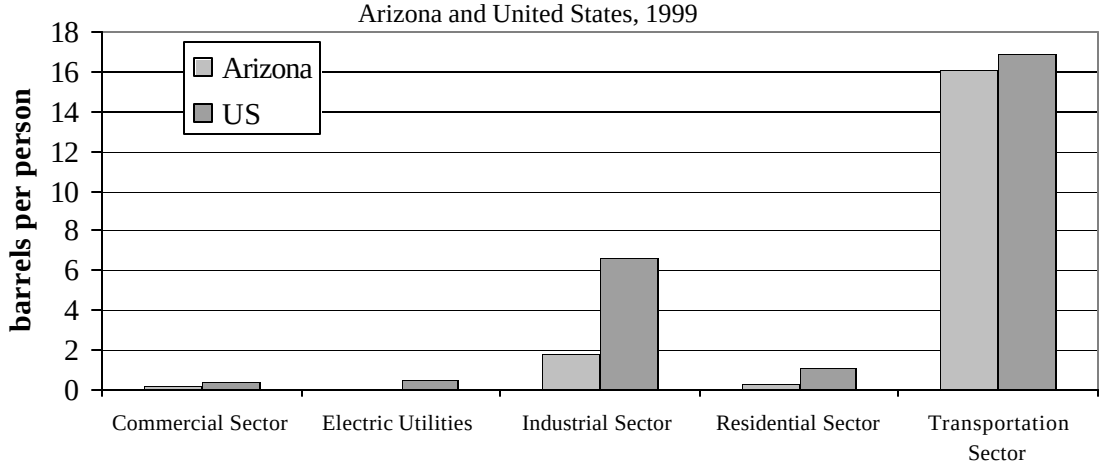
Figure 17
Status of Natural Gas Unbundling in 2001



Source: US Department of Energy, Information

Arizona's per capita petroleum use is less than the national average in every end use sector. Arizona ranked 48th in the nation in per capita usage of petroleum products in 1999, ahead of New York and Rhode Island. In Arizona, this low per capita ranking is due to very low usage of petroleum products in the non-transportation sectors, particularly the industrial sector.

Figure 18
Per Capita Petroleum Usage by End Use Sector
Arizona and United States, 1999



Source: Department of Energy, Energy Information Administration, *State Energy Data Report, 1999*

In the transportation sector, Arizona's per capita petroleum product usage is five percent below the national average. In all other sectors, Arizona's per capita usage is 60 percent or more below the national average and the state is ranked in the bottom seven or less in the United States.

In the residential and commercial sectors, low per capita usage is primarily due to low usage of distillate fuel and kerosene and liquid petroleum gas (LPG)[78]. One use for these fuels in homes and businesses is for heating purposes; Arizona's relatively warm climate reduces consumption of these fuels. Very few of Arizona' electric power plants use oil as a primary fuel source. For this reason, Arizona's electric utility sector uses 97 percent less petroleum per capita than the national average.

Per capita petroleum usage in Arizona's industrial sector is 73 percent below the national average, ranking Arizona 46th in the nation for industrial consumption of petroleum products. Arizona's industrial usage is most different from the national average for LPG and miscellaneous petroleum products[79]. These products are used in industries like petroleum refining, chemicals, paint manufacturing, and plastics manufacturing. Because of supply chain considerations, these products tend to be consumed more heavily in states with nearby petroleum refineries. For example, 81 percent of industrial LPG usage was consumed in Texas or Louisiana, home to a large number of petroleum refineries. For miscellaneous petroleum products, 38 percent of US consumption was consumed in these two states. Arizona's lack of petroleum refineries make it unlikely that a firm that is a heavy user of petroleum products would choose to locate here.

Usage By Fuel

Figure 19 shows per capita usage of each of the fuels used in Arizona in 1999 for the United States and for Arizona. For most fuels, Arizona's per capita usage is less than the national average.

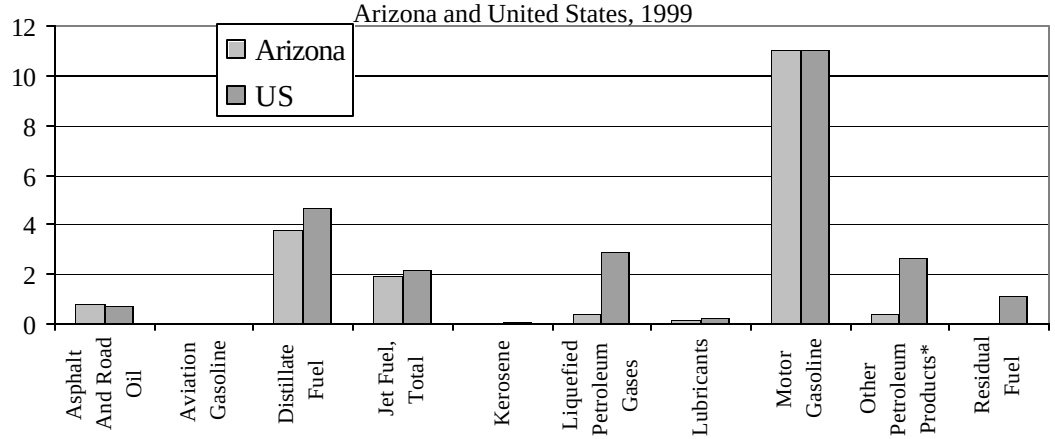
Motor gasoline made up 60 percent of all petroleum products consumed in Arizona in 1999. For the nation, motor gasoline makes up only 43 percent of total petroleum products consumed. Arizona's per capita usage of gasoline is similar to the national average, at just over 10 barrels per person per year. Arizona ranks 34th in per capita consumption of gasoline.

Distillate fuel makes up the second-largest portion of Arizona's petroleum product consumption, at 21 percent of total consumption. Distillate fuels include diesel fuel and home heating oil. Arizona's per capita consumption of distillates is 44th highest in the nation; almost 20 percent less than the national average. Although per capita usage of distillates is below the national average in every end-use category, the majority of the shortfall is due to the residential class. There is very little use of home heating oil in Arizona. Arizona's per capita use of distillate fuels for transportation is essentially the same as the national average.

Jet fuel is third, with 11 percent of total petroleum product consumption. Jet fuel consumption in Arizona was 12 percent less than the national average, but ranked 14th in the nation.[80] Aviation gasoline is not a major fuel source, making up less than one percent of total petroleum product usage in the US and Arizona. However, Arizona's per capita usage of this fuel is 13 percent above the national average, ranking the state 19th in per capita usage of this fuel. As with jet fuel, the relatively high ranking indicates the importance of aviation in Arizona.

[78] LPGs include ethane, ethylene, propane, propylene, normal butane, butylene, isobutane, and isobutylene.
[79] This category includes: aviation gasoline blending components, crude oil, petroleum feedstocks, motor gasoline blending components, natural gasoline, petroleum coke, plant condensate, pentanes plus, still gas, special napthas, unfinished oils, unfractionated steam, and waxes.
[80] The national average is skewed upward by Alaska's high per capita usage (approximately 17 times the national average.) Arizona's per capita usage of jet fuel is about six percent above the national average excluding Alaska.

Figure 19
Total Per Capita Petroleum Usage:
Arizona and United States, 1999



*Other includes petroleum products mostly used in the industrial sector
Source: Department of Energy, Energy Information Administration, State Energy Data Report, 1999

After jet fuel, the next largest category is asphalt and road oils, with about four percent of total consumption. Arizona's use of this product exceeds the national average by seven percent, ranking Arizona 25th in the nation. These products are used primarily for road construction; Arizona's rapid growth has fueled demand for new roads resulting in increased demand for asphalt and road oils.

No other fuel comprises more than two percent of Arizona's consumption of petroleum products. LPG is two percent of total consumption and lubricants are one percent. Miscellaneous petroleum products comprise two percent of total consumption. The state has very small amounts of consumption of kerosene (less than half a percent of total consumption).

Arizona uses very little residual fuel. Residual fuel is four percent of national consumption of petroleum products, but less than half of one percent of Arizona's consumption. About eighty percent of the residual fuel used in the United States is consumed in the transportation and electric utility industries. In the transportation sector, residual fuel is used as fuel for large marine vessels and for locomotives. In the electric utility industry, residual fuel is used as fuel for power plants. In 1999, Arizona had no consumption of residual fuel in the transportation sector. The electric utility sector consumed 27 percent of the residual fuel used in Arizona. Industrial users consumed the rest. Arizona ranks 48th in per capita residual fuel use, ahead of Colorado and Idaho.

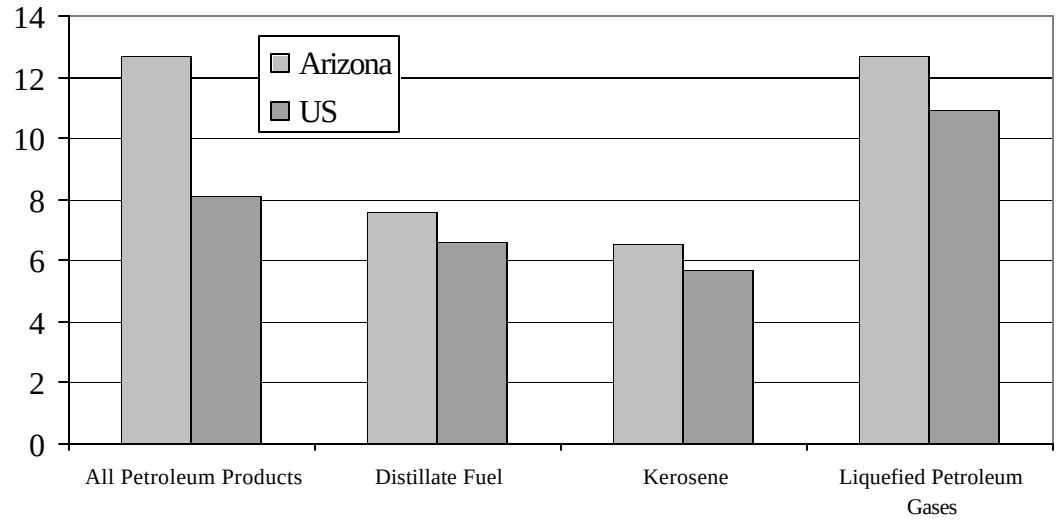
Prices

In 1999, Arizona faced above average prices for all types of petroleum products consumed in the state except asphalt and road oil. Overall, Arizonans paid $8.51 per million Btu for petroleum products, compared to a national average of $7.33 per million Btu. This was the third highest overall price in the nation, behind Vermont and Nevada.

Figure 20 shows average prices by fuel for the residential sector. Overall, Arizona's residential customers pay $12.69 per million Btu for petroleum products, the third highest average price in the nation. This price is misleadingly high and reflects Arizona's relatively higher proportion of residential consumption for LPG, the most expensive product consumed in the residential sector. Price differentials for the three

residential fuels were smaller. On average, Arizona's residential customers paid 14 to 17 percent more than the national average for kerosene, distillate fuel, and LPG.

Figure 20
Petroleum Prices, Residential
Arizona and United States, 1999



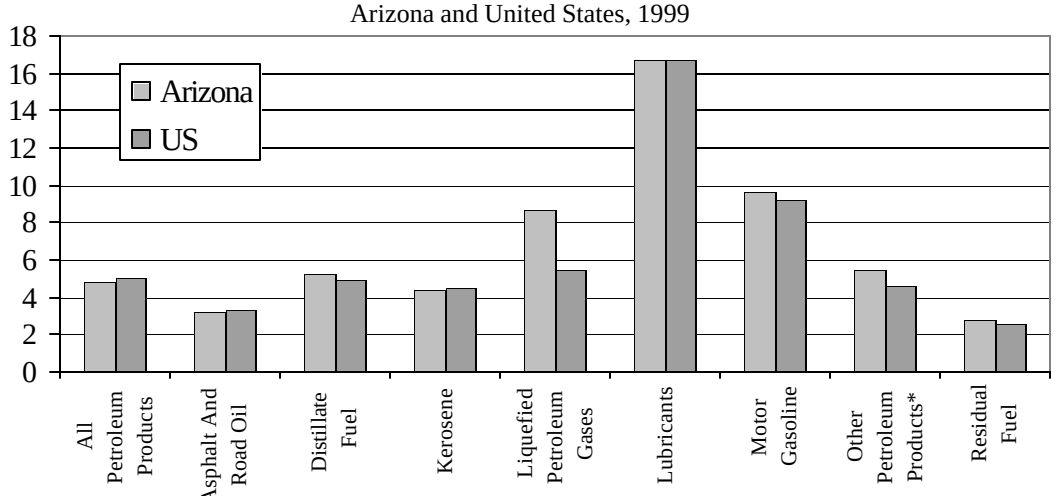
Source: Department of Energy, Energy Information Administration, *State Energy Price and Expenditure Report 1999*

Figure 21 lists average prices in 1999 for the commercial sector. On average, Arizona's commercial customers paid the ninth highest prices in the nation for petroleum products. Commercial prices for distillate fuel were fourth highest in the nation and almost 30 percent above the national average. Prices for LPG were also fourth highest, but were only 17 percent above the national average. Commercial kerosene prices were 23 percent above the national average. Commercial motor gasoline prices were approximately the same as the national average.

Average prices paid by industrial customers were three percent below the national average, and 33rd highest in the nation. As with residential customers, the main difference for this price differential was differences in product mix consumed. Asphalt and road oil makes up about 43 percent of the petroleum products consumed by the industrial sector in Arizona in 1999, but only 11 percent of national usage. This works to lower Arizona's average price for industrial users because the price of asphalt and road oil is among the lowest in the industrial class. Overall, industrial prices were much closer to national average prices than in other classes. The main exceptions were prices for LPG, which were 59 percent above the national average, and prices in the "other" category, which were 20 percent above the national average. Figure 22 shows average industrial prices for the United States and Arizona.

Figure 22
Petroleum Prices, Industrial

Arizona and United States, 1999

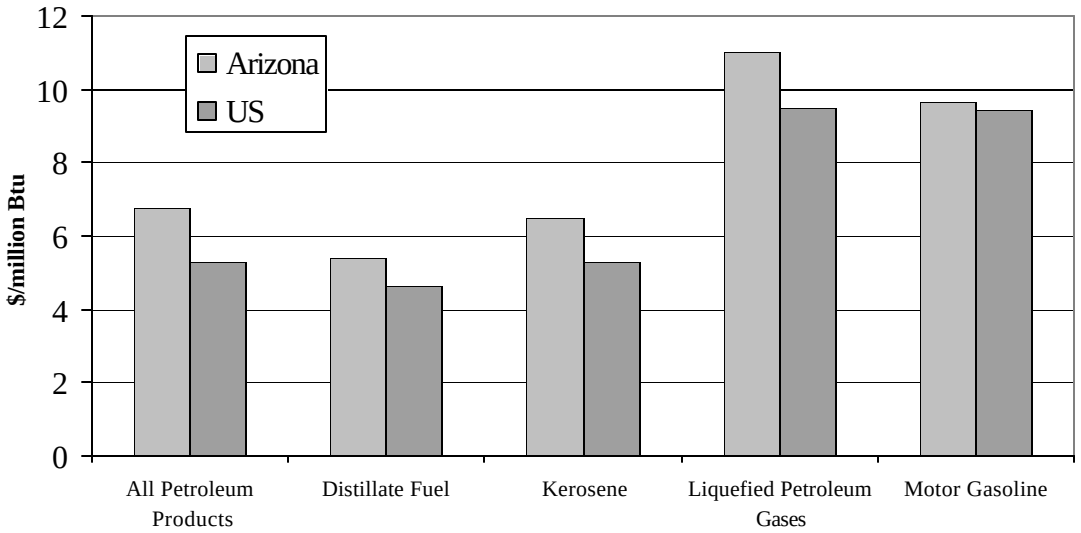


*Other includes gasoline blending components, petroleum feedstocks, natural gasoline, petroleum coke, plant condensates, pentanes plus, still gas, special napthas, unfinished oils, unfractionated steam, and waxes

Source: Department of Energy, Energy Information Administration, State Energy Data Report, 1999

Figure 21
Petroleum Prices, Commercial Sector

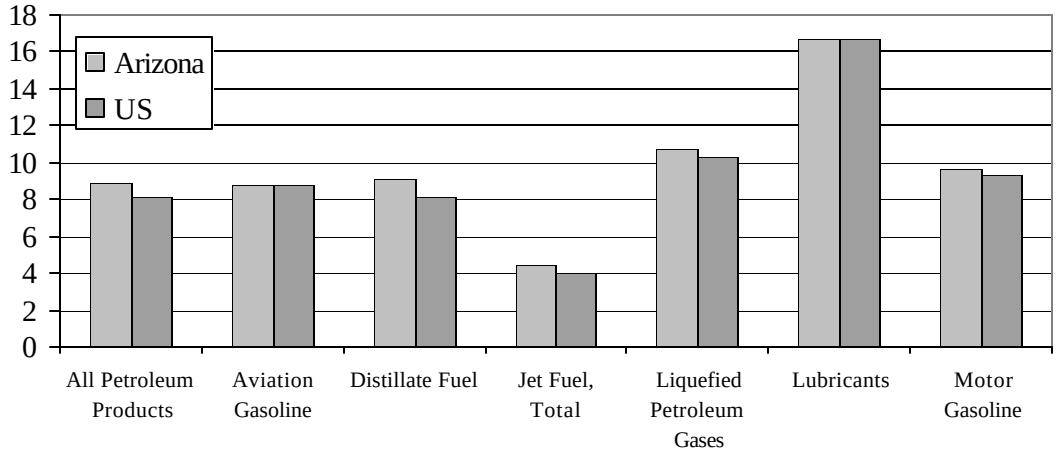
Arizona and United States, 1999



Source: Department of Energy, Energy Information Administration, *State Energy Price and Expenditure Report 1999*

Average prices for transportation fuels in Arizona were fifteenth highest in the nation and nine percent above the national average. Distillate fuel and jet fuel prices were both about 11 percent above the national average, ranked ninth and tenth, respectively. Prices for motor gasoline, LPG, aviation gasoline, and lubricants were not significantly different from the national average.

Figure 23
Petroleum Prices, Transportation
Arizona and United States, 1999



Source: Department of Energy, Energy Information Administration, *State Energy Price and Expenditure Report 1999*

Petroleum Production[81]

Arizona has a small amount of petroleum production. The 25 small "stripper wells" in the state produced approximately 156 barrels per day in 2000, placing Arizona 30th in production out of 31 oil-producing states. Arizona's petroleum reserves account for less than one percent of U.S. crude oil proved reserves.

Petroleum Transportation

Arizona has a few pipelines crossing the state. The All American and ARCO pipelines transport crude oil. The Kinder Morgan pipeline system transports refined products.[82] The eastern part of the Kinder Morgan pipeline connects Phoenix and Tucson to El Paso and gives Arizona access to petroleum products from Gulf Coast refineries. (East Line) The western part of the Kinder Morgan line connects California refineries to Phoenix and Tucson. (West Line) The Kinder Morgan system transports gasoline, diesel fuel, and jet fuel.[83]

Since Arizona has no refineries, the state must import all of its petroleum products. About 60 percent of Arizona's petroleum product consumption is imported through the West Line from California. The bulk of the remainder comes from Texas over the East Line. As of 2002, approximately 126,000 barrels per day of refined products are transported into the Phoenix and Tucson area via the West Line. Gasoline makes up about half of this total, diesel and jet fuel make up about 25 percent each. About 87,000 barrels per day are imported into the state via the East Line. The majority of this (68,000 barrels per day) is gasoline. Diesel and jet fuel make up about 10 percent each of the total.[84]

---

[81] Department of Energy, Energy Information Administration, "Petroleum State Profiles" http://tonto.eia.doe.gov/oog/info/state/az.asp
[82] Department of Energy, Energy Information Administration, "Petroleum State Profiles" http://tonto.eia.doe.gov/oog/info/state/az.asp
[83] California Energy Commission, Gulf Coast to California Pipeline Feasibility Study, prepared by Interliance LLC, March 2002, page 9-10
[84] California Energy Commission "US Gulf Coast to California Pipeline Feasibility Study," Committee Workshop, Sacramento California, March 14, 2002, slide 7

The Longhorn pipeline is expected to begin operations in 2002 and will transport petroleum products from Houston to El Paso. This pipeline will have an initial capacity of 70,000 to 75,000 barrels per day, and will have an ultimate capacity of 225,000 barrels per day. However, the Kinder-Morgan pipeline from El Paso to Tucson and Phoenix is currently operating at capacity. Because of this, future increases in demand for petroleum products in Arizona must be met by the West Line, which has spare capacity in the near term.[85]

The California Energy Commission is currently exploring the feasibility of constructing a pipeline to connect Texas and California.[86] This proposed pipeline would take advantage of the new Longhorn pipeline and give California markets access to products from Gulf Coast refineries. Several developments have led the California Energy Commission to become interested in a possible pipeline. First, in response to environmental concerns, California law requires a phase out of MTBE additives into gasoline by the end of 2002. Although it has been delayed, this phase out will have the effect of reducing the production of gasoline by California refineries. This requirement, coupled with projected increases in refined product demand in California and the relative isolation of West Coast markets from alternative sources of petroleum imports, has led to an interest in a pipeline from the U.S. Gulf Coast to California.[87] Because Arizona imports a large portion of its petroleum products from California, shortages in the California market will almost certainly affect prices and availability of refined products in Arizona.

CONCLUSION

Almost every sector of Arizona's energy industry is undergoing changes that will provide challenges for the providers and consumers of energy in the state. For the electricity industry, Arizona has seen a boom in the construction of new electric generation plants that should ensure a plentiful supply of electricity for years to come. Prices in Arizona compare favorably to the nation, and should remain somewhat lower than prices in California and the desert Southwest. However, like much of the nation, eliminating transmission bottlenecks will be a continuing challenge, particularly given Arizona's rapidly growing population. In the natural gas and petroleum industries, the main challenges are also related to transmission. Arizona must import all of the natural gas and petroleum products that are consumed in the state. Most of these products are shipped to the state via pipelines. As these pipelines reach capacity, new facilities must be built.

[85] California Energy Commission "US Gulf Coast to California Pipeline Feasibility Study," Committee Workshop, slide 9

[86] California Energy Commission "US Gulf Coast to California Pipeline Feasibility Study," Committee Workshop slide 10

[87] California Energy Commission "MTBE Phase Out in California," Consultant Report by Stillwater Associates, March 2002.